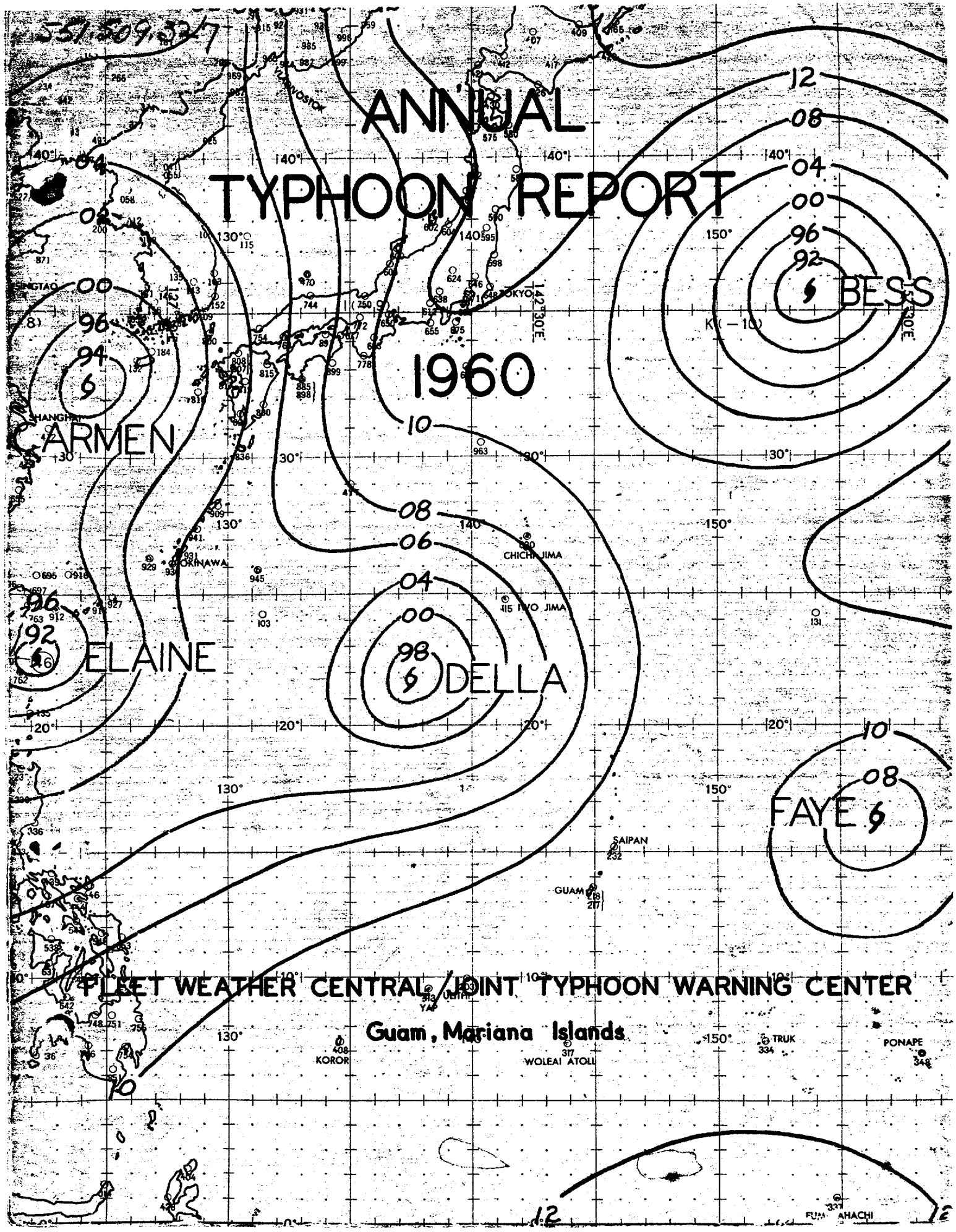
ANNUAL
TYPHOON REPORT
1960
CARMEN
ELAINE
DELLA
BESS
FAYE
12
08
04
00
96
92
94
10
06
98
SAIPAN
GUAM
CHICHI JIMA
OKINAWA
SHANGHAI
TOKYO
KOROR
WOLEAI ATOLL
TRUK
PONAPE
AHACHI
FLEET WEATHER CENTRAL/JOINT TYPHOON WARNING CENTER
Guam, Mariana Islands

U.S. FLEET WEATHER CENTRAL/
JOINT TYPHOON WARNING CENTER
COMNAVMARIANAS BOX 12
FPO SAN FRANCISCO, CALIFORNIA

CHARLES E. TILDEN
Commander, U. S. Navy

COMMANDING

ROBERT M. HOFFMANN
Lieutenant Colonel, USAF

DIRECTOR, JOINT TYPHOON WARNING CENTER

1 9 6 0

ANNUAL TYPHOON REPORT

Distribution List

Annual Typhoon Report

1 9 6 0

CNO (2)
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CINCPACFLT
CINCLANTFLT
COMNAVMARIANAS
COMNAVPHIL
COMNAVFORJAPAN
COMNAVFORKOREA
COMWESTSEAFRON
COMSEVENTHFLT
COMFIRSTFLT
COMPHIBPAC (2)
COMCRUDESPAC
COMASDEFORPAC
COMINPAC
COMSERVPAC
COMSTS (2)
PACFLT CARRIERS
PACFLT AV'S
SUPT NAVPGSCOL (2)
CAF WEATHER CENTRAL, TAIWAN
DIRECTOR, ROYAL OBSERVATORY, HONG KONG
NATIONAL GOVERNMENT OF REPUBLIC OF CHINA
REPUBLIC OF KOREA
JAPAN
SEATO COUNTRIES

CO FLEWEACEN PEARL
CO FLEWEACEN ALAMEDA
OIC FLEWEAFAC SANGLEY PT
OIC FLEWEAFAC YOKOSUKA
OIC FLEWEAFAC MIAMI
OIC FLEWEAFAC SAN DIEGO
CO AEWRON ONE
CO AEWRON FOUR
OIC NWRF NORFOLK
NAVREP NWRC ASHEVILLE N.C.
HEADQUARTERS, AWS (5)
HEADQUARTERS, 1ST WW (10)
HEADQUARTERS, 1ST WW (ADVON) (24)
AFHLO, JHWC, MIAMI
AFPCHLO, BASE WEATHER STATION,
HAMILTON AFB, CALIF
HEADQUARTERS, 9TH WG (2)
55TH WEATHER RECONN SQDRON
56TH WEATHER RECONN SQDRON (2)
CHIEF, US WEATHER BUREAU (2)
MIC, PSO, USWB HONOLULU (12)

INTRODUCTION

This report is published annually, and summarizes Western North Pacific and Central North Pacific tropical cyclones. During 1960, no tropical cyclones were reported in the Central North Pacific.

Effective on 1 May 1959, CINCPAC, through CINCPACFLT, redesignated Fleet Weather Central, Guam as Fleet Weather Central/Joint Typhoon Warning Center (FWC/JTWC), Guam with the following additional responsibilities:

1. To provide warnings to U.S. Government agencies for all tropical cyclones west of 180 degrees longitude.

2. To determine tropical cyclone reconnaissance requirements and priorities.

3. To conduct investigative and post analysis programs including the preparation of annual typhoon summaries.

4. To conduct forecasting and detection research as practicable.

Fuchu Air Force Weather Central, assisted as necessary by Fleet Weather Facility Yokosuka, was designated as alternate JTWC in case of failure of FWC/JTWC, Guam. Responsible for the issuance of tropical warnings for the Central North Pacific, east of 180 degrees and west of 140 degrees, is the Joint Hurricane Warning Center in Hawaii, a coordinated agency composed of the U.S. Weather Bureau, Honolulu, the Air Force Kunia Weather Center, and Fleet Weather Central, Pearl Harbor.

The JTWC, which is an integral section of FWC/JTWC, Guam, is staffed by two Air Force and two Navy meteorologists, and three enlisted men from each service. The senior Air Force Officer has been designated as the Director, JTWC.

The background for the cover of this report is the 1200Z surface chart on 22 August 1960.

TABLE OF CONTENTS

CHAPTER I

SUMMARY OF TROPICAL CYCLONES OF 1960

A. GENERAL

During 1960, in that area of the Pacific west of 140° W and N of the equator, 56 tropical disturbances were numbered as cyclones. Of this number, 3 had warnings issued as tropical depressions only, 8 had warnings issued as tropical storms, and 19 achieved full typhoon intensity. The term "tropical cyclone" or "cyclone", as used herein, is defined as a suspected tropical cyclonic circulation which appears capable of intensification. A cyclone is assigned a number for purposes of reconnaissance and to assure that records regarding it are not confused with those of another circulation. A tropical depression is a tropical cyclone with a confirmed cyclonic circulation, usually small in area, for which warnings are being issued, and whose surface wind speeds do not exceed 33 kts. The numbering of cyclones is not related to the numbering of tropical depressions.

The typhoons were KAREN, MARY, OLIVE, POLLY, SHIRLEY, TRIX, VIRGINIA, WENDY, BESS, CARMEN, DELLA, ELAINE, FAYE, KIT, LOLA, MAMIE, NINA, OPHELIA and PHYLLIS. The tropical storms were LUCILLE, NADINE, ROSE, AGNES, GLORIA, HESTER, IRMA and JUDY.

Warnings were issued on 157 calendar days, and a total of 776 warnings were issued which compares with a total of 583 warnings issued during 1959. After the Season began with Typhoon KAREN, the greatest interval between tropical disturbances was 30 days (between KAREN and T.S. LUCILLE).

Perhaps one of the most interesting features of the 1960 Season was the unusual monthly distribution of typhoons. During August there were 8 typhoons, while in September there were none. Long period climatological records reveal that only during two other years since 1884 were there 8 or more typhoons reported in August (1940, 1942). The same records also show that only in two other years were there no typhoons reported in September (1885, 1904).

The tracks of all typhoons and those of Tropical Storms LUCILLE and NADINE are contained in this chapter. The two tropical storms are included because of reference to them in the press as typhoons. Typhoon tracks for months having one or more typhoons are also included in this chapter. Individual best tracks of all typhoons will be found in Chapter V.

B. AREAS OF FORMATION AND DEVELOPMENT

During 1960, in the area of responsibility of the Joint

Hurricane Warning Center, Hawaii, there were no tropical disturbances for which names, tropical depression numbers or cyclone numbers were assigned.

The typhoons of 1960 occurring within the FWC/JTWC area of responsibility developed south of 25 N, west of 161 E and north of 6 N. Typhoons KAREN, MARY and ELAINE became typhoons in the South China Sea, however KAREN originated in the Pacific and moved across the southern Philippines before becoming a typhoon. While at tropical storm intensity, Typhoons VIRGINIA, DELLA, OPHELIA and PHYLLIS passed within 500 mi of Guam, and Typhoon MAMIE, the largest of the Season, became a typhoon within 250 mi of Guam.

The majority of typhoons were initially detected by surface analyses, and before reaching typhoon strength a period of intensification took place which lasted from one to seven days. It is generally accepted that an initially developed cyclonic circulation must exist under an area of substantial divergence aloft before the circulation can intensify to typhoon strength. During 1960 this statement was substantiated except for the formation of Typhoon WENDY, which appeared to have formed and reached typhoon intensity during a period when its surface position was near an upper level cyclone.

C. SIZE AND INTENSITY

The typhoons of 1960 were definitely less intense than those of 1959. The Table, "1960 Typhoon Data Summary" is provided in this chapter for comparison of typhoons. Data contained in the Table and other information clearly show that the typhoons of 1960 were of weak to moderate intensity. Certainly there were no typhoons during 1960 which compared in intensity to Typhoons JOAN and VERA of 1959. Typhoon MAMIE was the largest of the 1960 Season with the radius of 50 kt surface winds extending 350 mi. Typhoons DELLA, NINA and OPHELIA all had a radius of 50 kt surface winds of 250 mi. Typhoon KAREN, the smallest, had a radius of 50 kt surface winds of only 30 mi. The lowest central surface pressure reported by reconnaissance was 918 mb, reported on both Typhoons TRIX and DELLA. This contrasts with the 1959 season when 6 typhoons had central surface pressures of less than 915 mb, and Typhoons JOAN and VERA had central pressures of 891 and 896 mb, respectively.

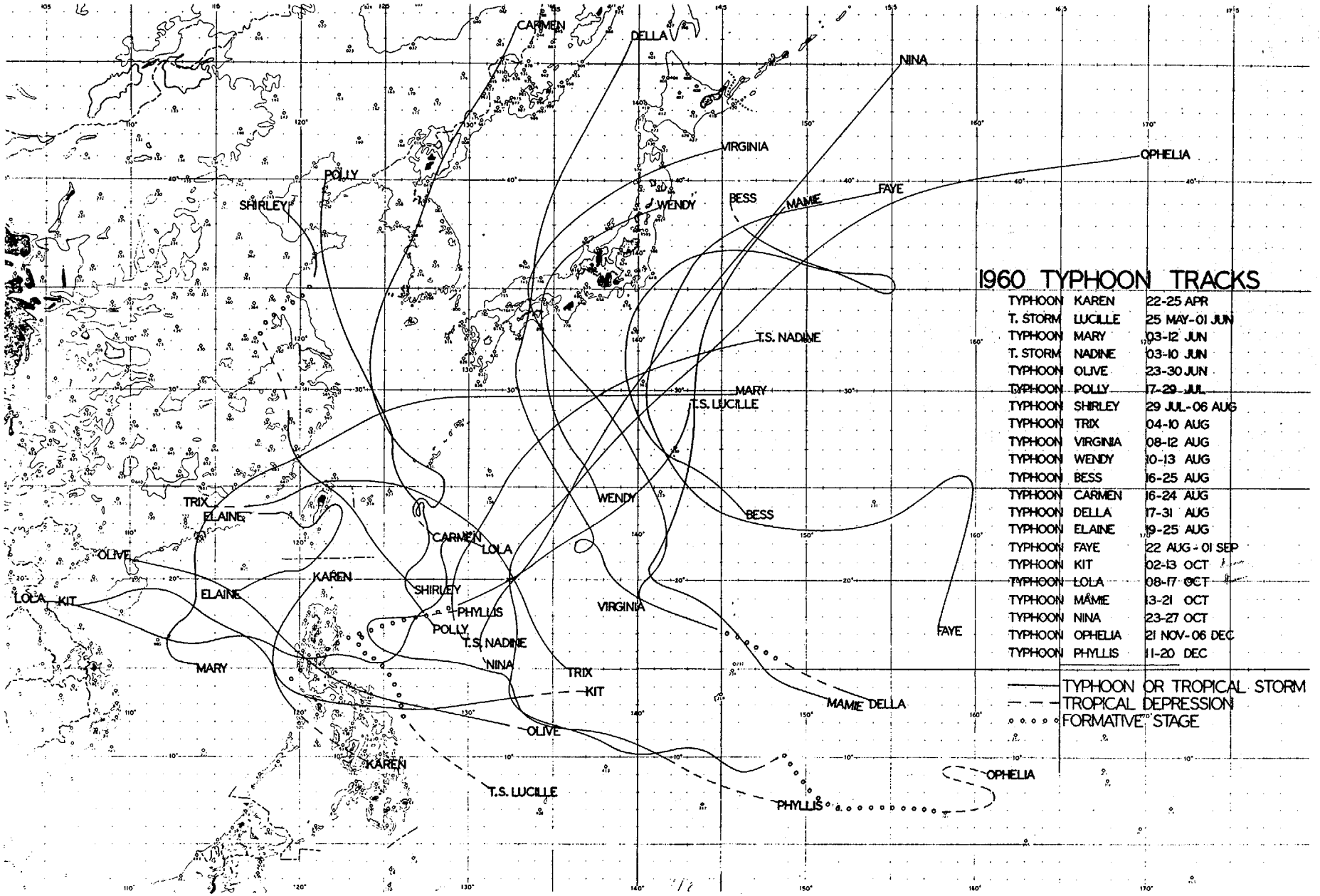
When the western Pacific high at the 200-300 mb level is primarily one large cell, it appears that typhoons are

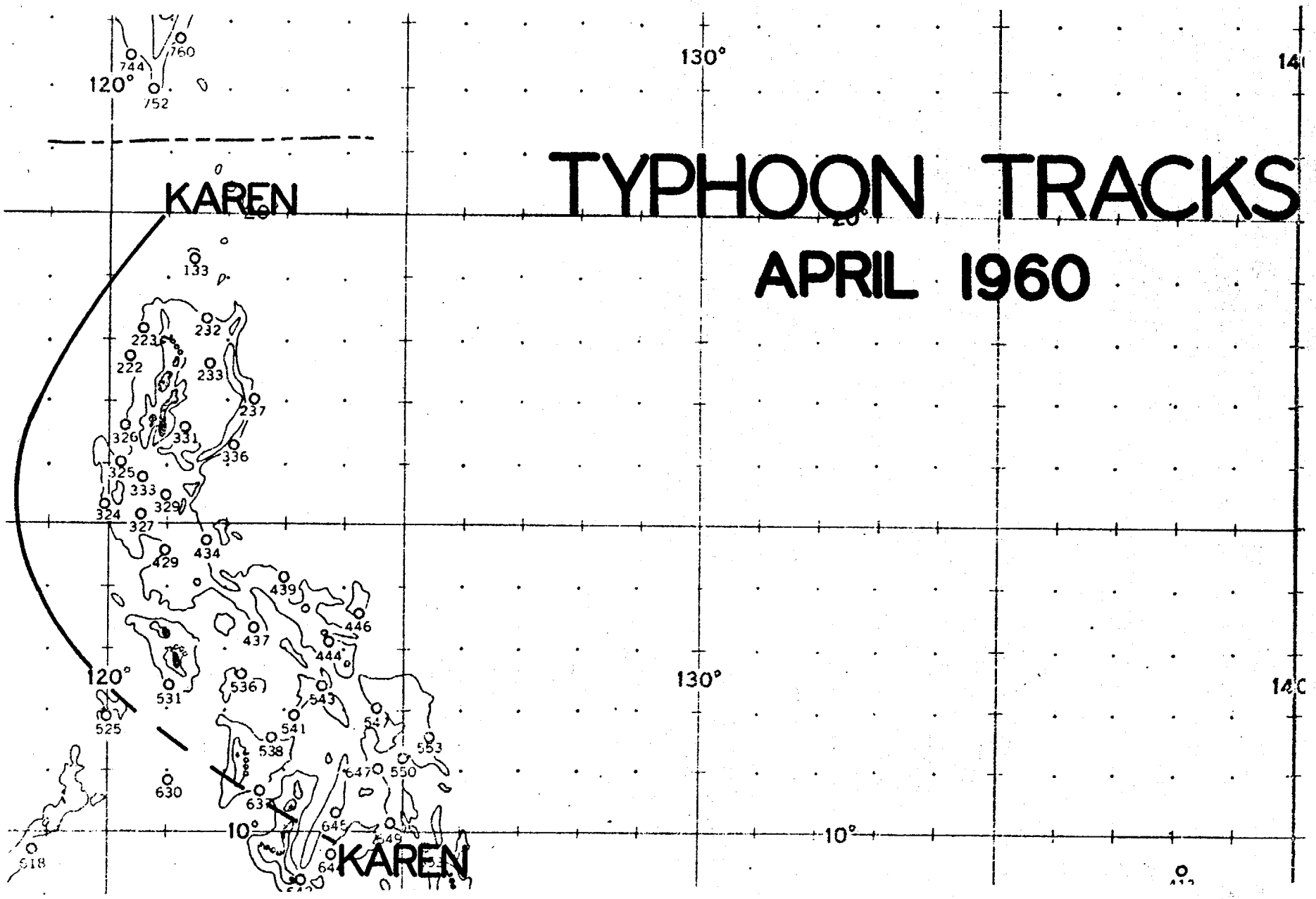
more intense and that there is a greater frequency of large typhoons. The reverse appears to be true when the western Pacific high consists of several small cells at the 200-300 mb levels, i.e., the typhoons are of weak or moderate intensity, and few large typhoons occur. The ideas expressed in the foregoing statements are considered worthy of further investigation and research.

D. MOVEMENT

The 1960 Typhoon Season was one of unusual tracks. From a perusal of the chart showing all tracks of 1960, it is easy to understand why the chart is called a "plate of worms". Typhoons BESS, DELLA and POLLY looped, and the tracks of BESS, ELAINE, and LOLA were such as to give ulcers to any Typhoon Duty Officer. Although unusual, the track of ELAINE was not unique, and was found to be quite similar to that of a typhoon of July 1924 (see chart this chapter). Few typhoons approach Luzon in the Philippines from the NE as LOLA did. Examination of the track chart reveals that typhoons of 1960 initially moved along a track between W and N with the exceptions of ELAINE and FAYE.

The speed of movement of typhoons varied considerably from typhoon to typhoon, as did the speed of movement within the life cycle of individual typhoons. For example: POLLY moved at an average speed of 6 kts while NINA moved at an average speed of 19 kts; POLLY moved at a speed of only 2 to 3 kts for 4 days before accelerating to 17 kts north of 30 N; and, during the early stages of development, OPHELIA, moved at less than 10 kts, but as she passed to the east of Japan, she moved at an average speed of 53 kts for a 24 hour period.


1960 TYPHOON TRACKS
TYPHOON KAREN 22-25 APR
T. STORM LUCILLE 25 MAY-01 JUN
TYPHOON MARY 03-12 JUN
T. STORM NADINE 03-10 JUN
TYPHOON OLIVE 23-30 JUN
TYPHOON POLLY 17-29 JUL
TYPHOON SHIRLEY 29 JUL-06 AUG
TYPHOON TRIX 04-10 AUG
TYPHOON VIRGINIA 08-12 AUG
TYPHOON WENDY 10-13 AUG
TYPHOON BESS 16-25 AUG
TYPHOON CARMEN 16-24 AUG
TYPHOON DELLA 17-31 AUG
TYPHOON ELAINE 19-25 AUG
TYPHOON FAYE 22 AUG - 01 SEP
TYPHOON KIT 02-13 OCT
TYPHOON LOLA 08-17 OCT
TYPHOON MAMIE 13-21 OCT
TYPHOON NINA 23-27 OCT
TYPHOON OPHELIA 21 NOV-06 DEC
TYPHOON PHYLLIS 11-20 DEC
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
CARMEN
DELLA
NINA
VIRGINIA
OPHELIA
POLLY
SHIRLEY
WENDY
BESS
MAMIE
FAYE
T.S. NADINE
MARY
T.S. LUCILLE
TRIX
ELAINE
OLIVE
KAREN
LOLA
KIT
PHYLLIS


TYPHOON TRACKS
APRIL 1960
KAREN
KAREN
120°
130°
10°
744
760
752
133
232
223
222
233
237
326
331
336
325
333
329
324
327
434
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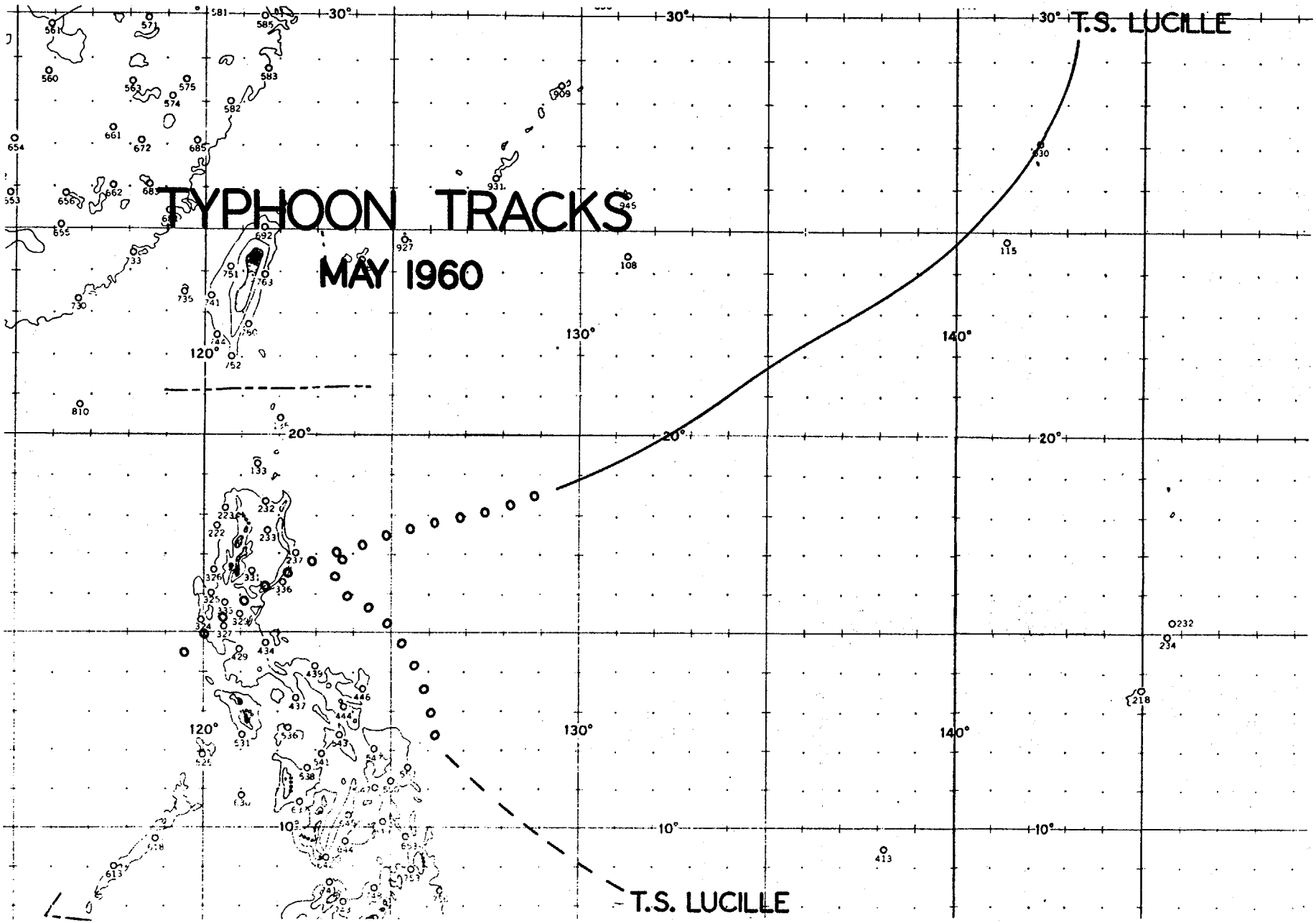
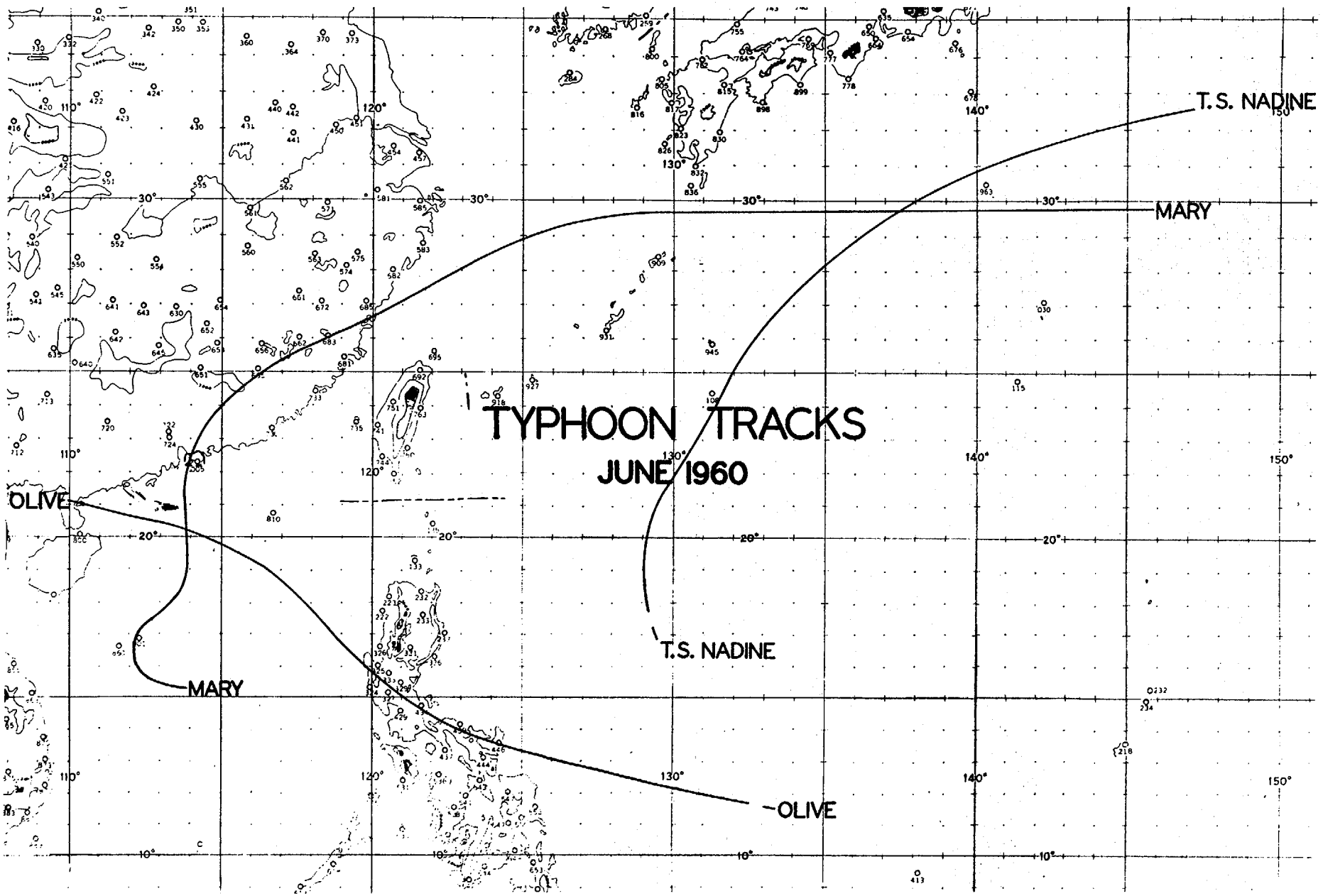
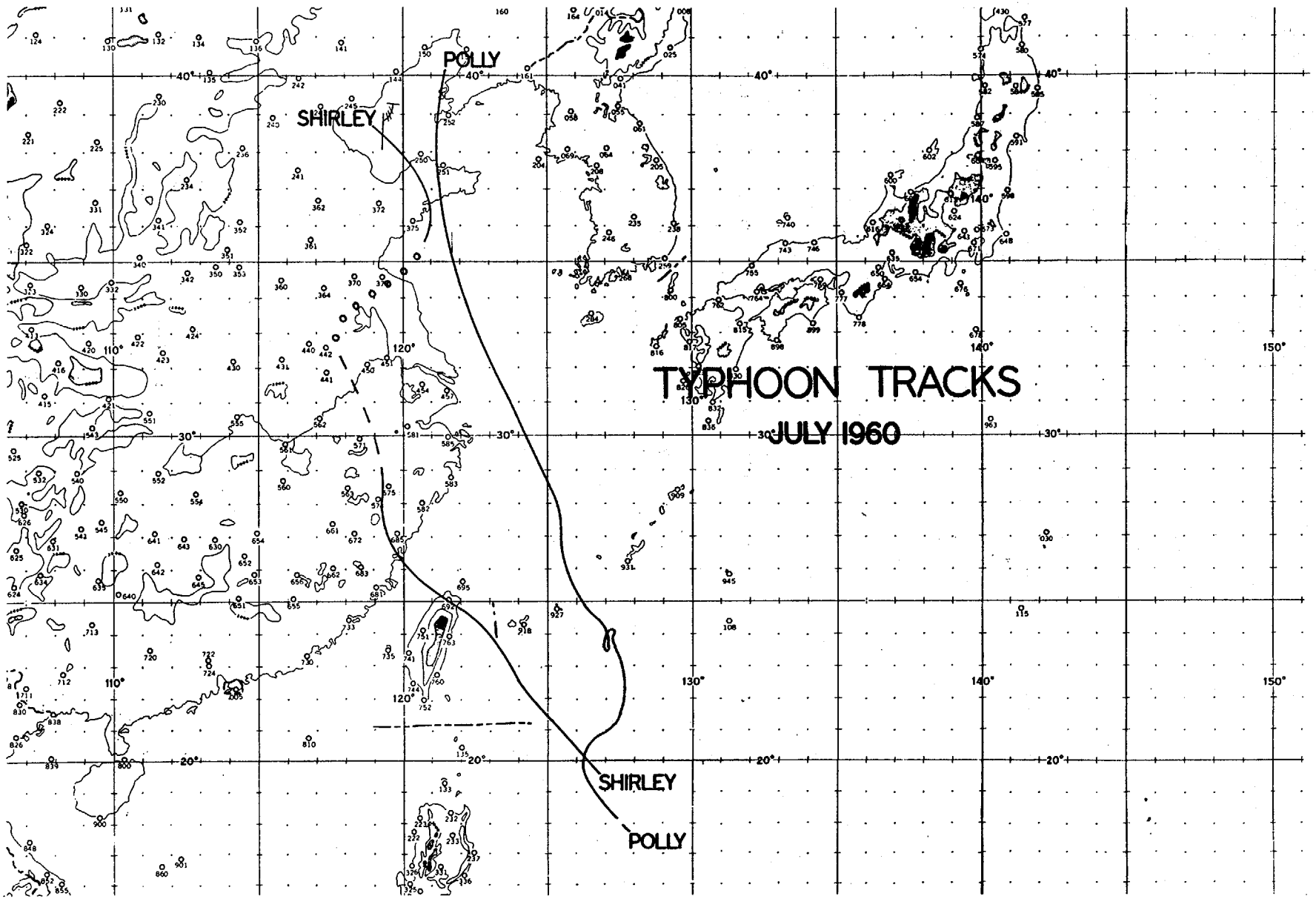
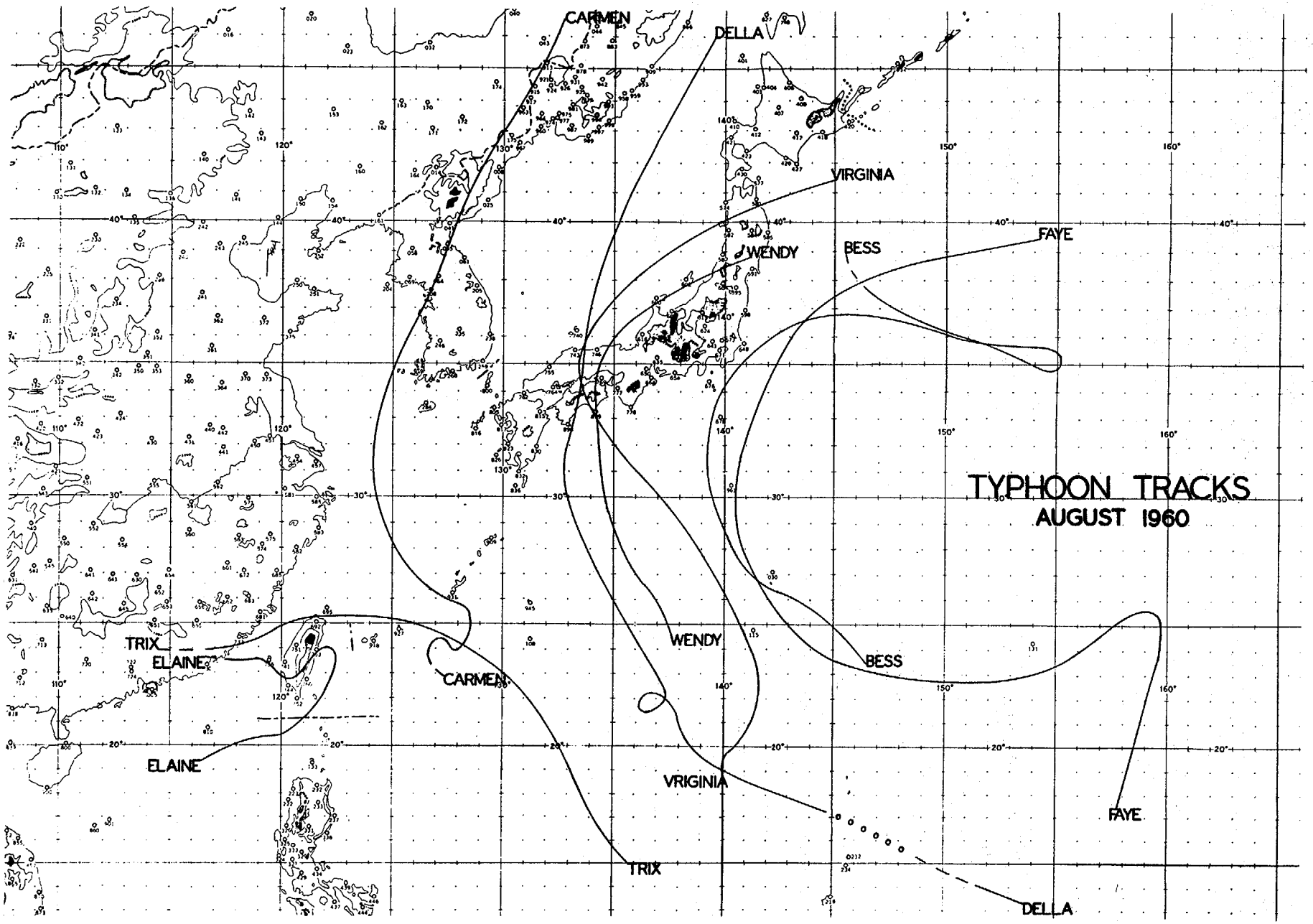
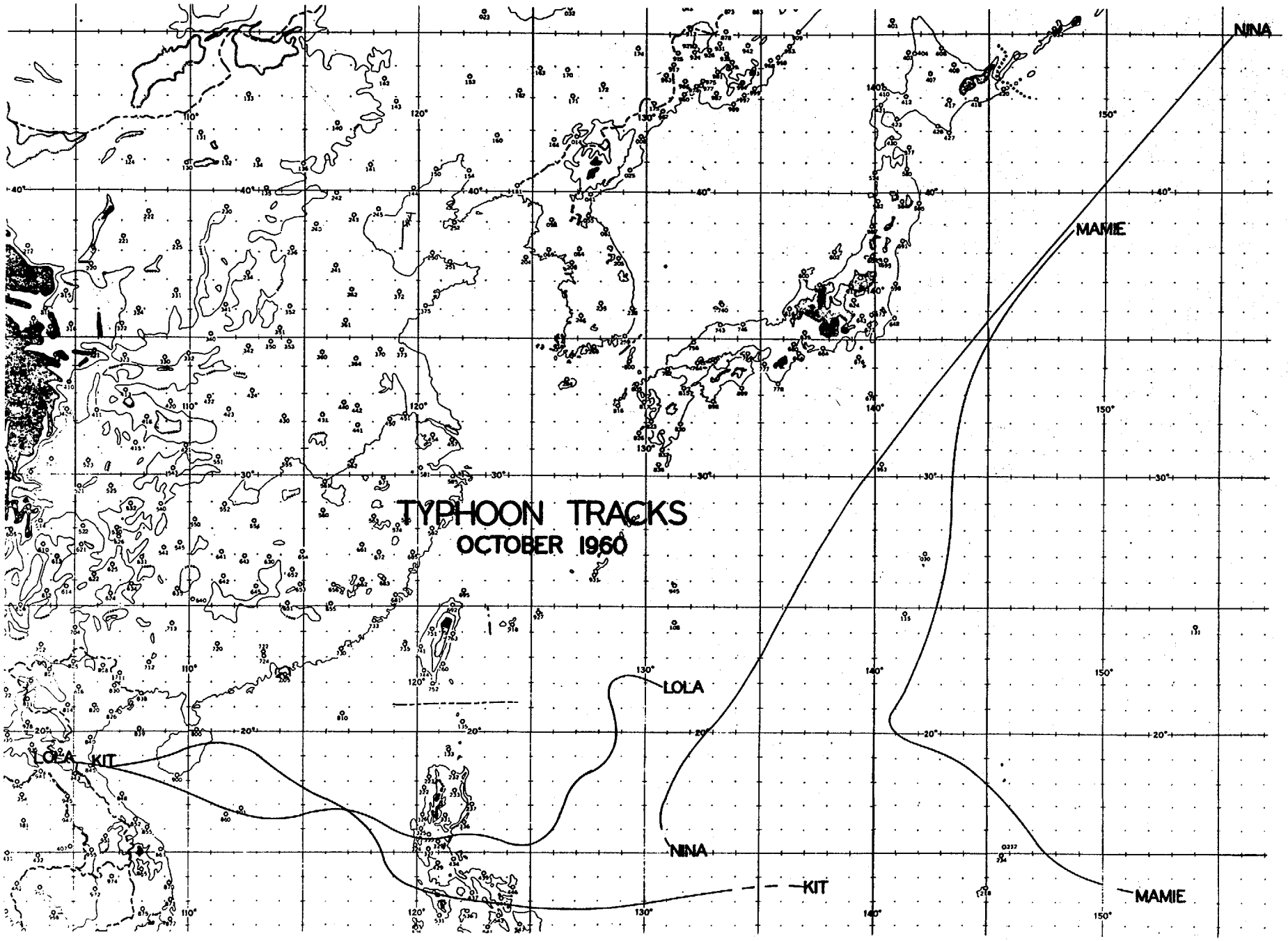
541
538
553
550
647
630
645
649
618

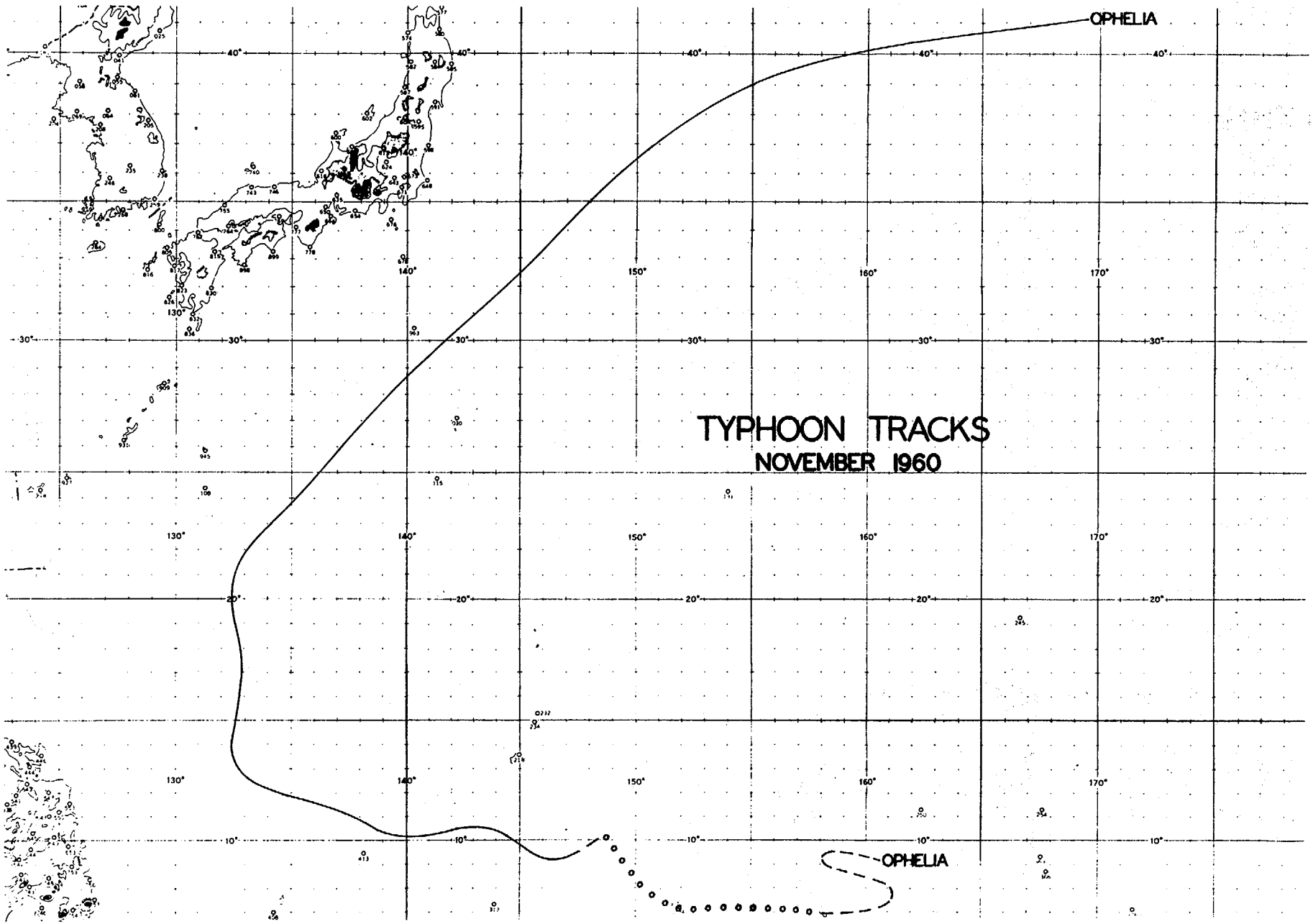

TYPHOON TRACKS
MAY 1960
T.S. LUCILLE
T.S. LUCILLE
30°
20°
10°
120°
130°
140°

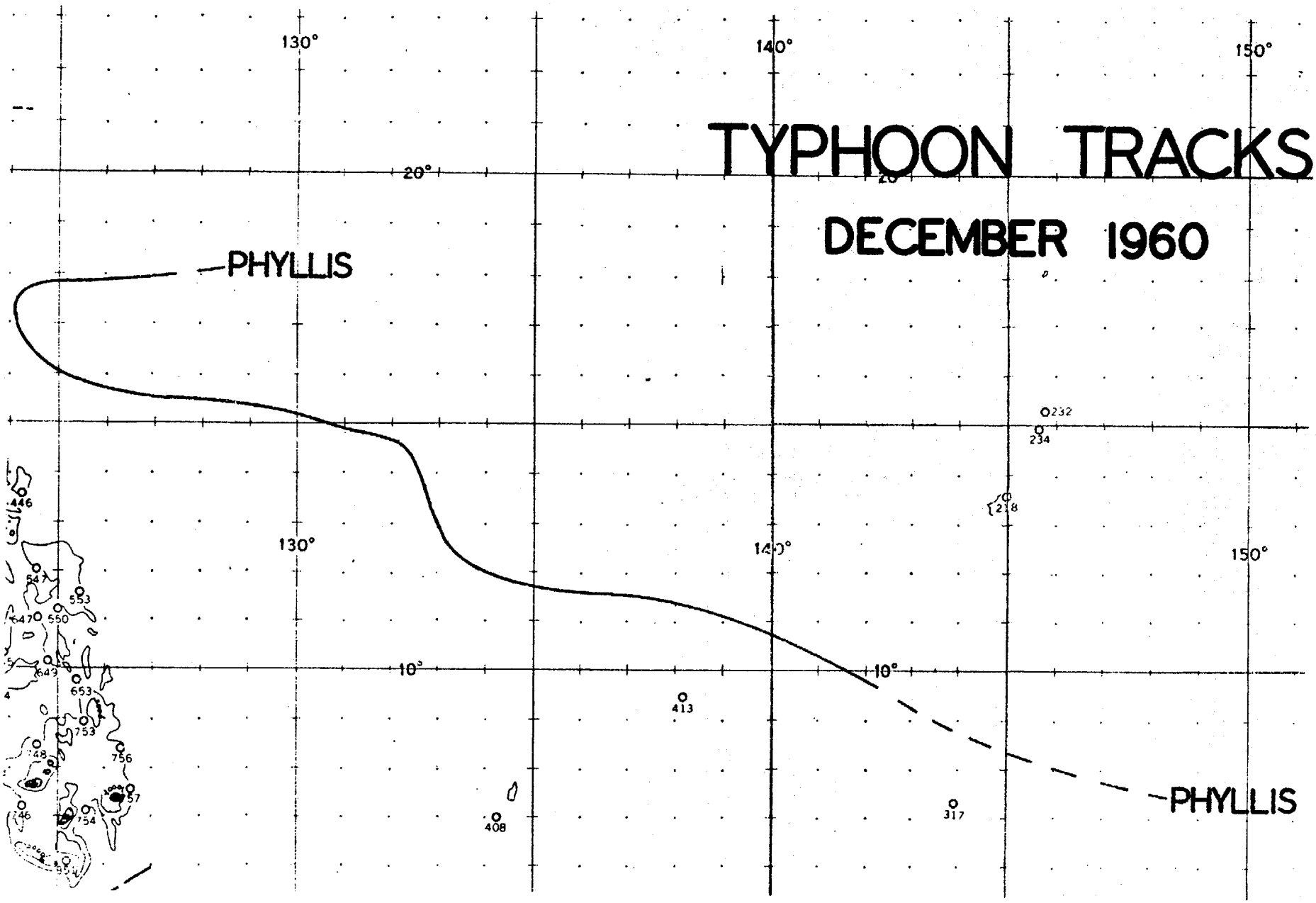

TYPHOON TRACKS
JUNE 1960
T.S. NADINE
MARY
OLIVE
T.S. NADINE
MARY
OLIVE


POLLY
SHIRLEY
TYPHOON TRACKS
JULY 1960
SHIRLEY
POLLY


CARMEN
DELLA
VIRGINIA
WENDY
BESS
FAYE
TRIX
ELAINE
CARMEN
WENDY
BESS
ELAINE
VRIGINIA
FAYE
TRIX
DELLA
TYPHOON TRACKS
AUGUST 1960


TYPHOON TRACKS
OCTOBER 1960
NINA
MAMIE
LOLA
KIT
LOLA
KIT
NINA
MAMIE


OPHELIA
TYPHOON TRACKS
NOVEMBER 1960
OPHELIA


TYPHOON TRACKS
DECEMBER 1960
PHYLLIS
PHYLLIS
130°
140°
150°
20°
10°
232
234
218
413
317
408
446
547
553
647
550
649
653
753
748
756
746
754
757

TROPICAL CYCLONES OF 1960

	CYCLONE	*PERIOD
01.	Investigation	03 Jan - 06 Jan
02.	Tropical Depression IVY (T.D. 1)	30 Jan - 01 Feb
03.	Tropical Depression JEAN (T.D. 2)	06 Mar - 08 Mar
04.	Investigation	30 Mar - 01 Apr
05.	Investigation	12 Apr - 18 Apr
06.	Typhoon KAREN	22 Apr - 25 Apr
07.	Tropical Storm LUCILLE	25 May - 01 Jun
08.	Typhoon MARY	03 Jun - 12 Jun
09.	Tropical Storm NADINE	03 Jun - 10 Jun
10.	Investigation	17 Jun - 18 Jun
11.	Investigation	20 Jun - 21 Jun
12.	Typhoon OLIVE	23 Jun - 30 Jun
13.	Investigation	28 Jun - 29 Jun
14.	Investigation	30 Jun - 01 Jul
15.	Investigation	01 Jul - 02 Jul
16.	Investigation	07 Jul - 08 Jul
17.	Investigation	12 Jul - 13 Jul
18.	Investigation	14 Jul - 16 Jul
19.	Typhoon POLLY	17 Jul - 29 Jul
20.	Investigation	23 Jul - 24 Jul
21.	Tropical Storm ROSE	25 Jul - 28 Jul
22.	Typhoon SHIRLEY	28 Jul - 06 Aug
23.	Investigation	31 Jul - 01 Aug
24.	Typhoon TRIX	01 Aug - 10 Aug
25.	Investigation	04 Aug - 05 Aug
26.	Investigation	06 Aug - 08 Aug
27.	Typhoon VIRGINIA	07 Aug - 12 Aug
28.	Typhoon WENDY	10 Aug - 13 Aug
29.	Tropical Storm AGNES	11 Aug - 16 Aug
30.	Typhoon BESS	13 Aug - 25 Aug
31.	Typhoon CARMEN	15 Aug - 24 Aug
32.	Typhoon DELLA	16 Aug - 31 Aug
33.	Typhoon ELAINE	19 Aug - 25 Aug
34.	Typhoon FAYE	22 Aug - 01 Sep
35.	Tropical Storm GLORIA	30 Aug - 04 Sep
36.	Tropical Storm HESTER	04 Sep - 10 Sep
37.	Investigation	08 Sep - 09 Sep
38.	Tropical Storm IRMA	10 Sep - 19 Sep
39.	Investigation	11 Sep - 13 Sep
40.	Investigation	13 Sep - 14 Sep

TROPICAL CYCLONES OF 1960 - (CONT'D)

	CYCLONE	*PERIOD
41.	Investigation	17 Sep - 18 Sep
42.	Investigation	20 Sep - 22 Sep
43.	Investigation	22 Sep - 23 Sep
44.	Tropical Storm JUDY	24 Sep - 29 Sep
45.	Investigation	29 Sep - 30 Sep
46.	Tropical Depression 19	30 Sep - 01 Oct
47.	Typhoon KIT	01 Oct - 13 Oct
48.	Typhoon LOLA	08 Oct - 17 Oct
49.	Investigation	11 Oct - 13 Oct
50.	Typhoon MAMIE	12 Oct - 21 Oct
51.	Typhoon NINA	16 Oct - 27 Oct
52.	Investigation	31 Oct - 04 Nov
53.	Typhoon OPHELIA	21 Nov - 06 Dec
54.	Investigation	30 Nov - 02 Dec
55.	Investigation	07 Dec - 09 Dec
56.	Typhoon PHYLLIS	09 Dec - 20 Dec

* The period shown covers the period from the date the cyclone was first assigned a cyclone number, until the final warning was issued, or if no warnings were issued, the date the cyclone dissipated.

1960 TYPHOON DATA SUMMARY

TYPHOON	FROM RECON MAX OBSVD SFC WND	FROM WARNINGS MAX SFC WND	FROM WARNINGS MAX RADIUS 100KT WND	FROM WARNINGS MAX RADIUS 50KT WND	FROM RECON MAX TEMP (C)	FROM RECON MIN 700MB HGT	FROM RECON MIN SLP (MBS)
KAREN	75	75	--	30	18	9940	988
*LUCILLE	---	45	--	---	--	----	---
MARY	65	75	--	75	16	9590	988
*NADINE	75	60	--	50	21	----	967
OLIVE	100	125	30	75	19	8800	950
POLLY	125	115	--	75	18	8630	950
SHIRLEY	130	125	30	100	21	7510	---
TRIX	130	135	50	100	24	8130	918
VIRGINIA	110	90	--	125	16	9590	971
WENDY	75	65	--	50	16	9960	986
BESS	60	70	--	100	18	9500	942
CARMEN	75	75	--	150	18	9420	970
DELLA	100	105	--	250	18	9170	918
ELAINE	80	80	--	75	17	9610	976
FAYE	135	135	40	125	18	8570	940
KIT	100	90	--	100	18	9200	966
LOLA	80	80	--	50	22	9600	978
MAMIE	150	115	40	350	23	8420	940
NINA	120	110	40	250	19	8810	954
OPHELIA	175	140	40	250	28	7960	928
PHYLLIS	110	115	30	150	21	9110	962

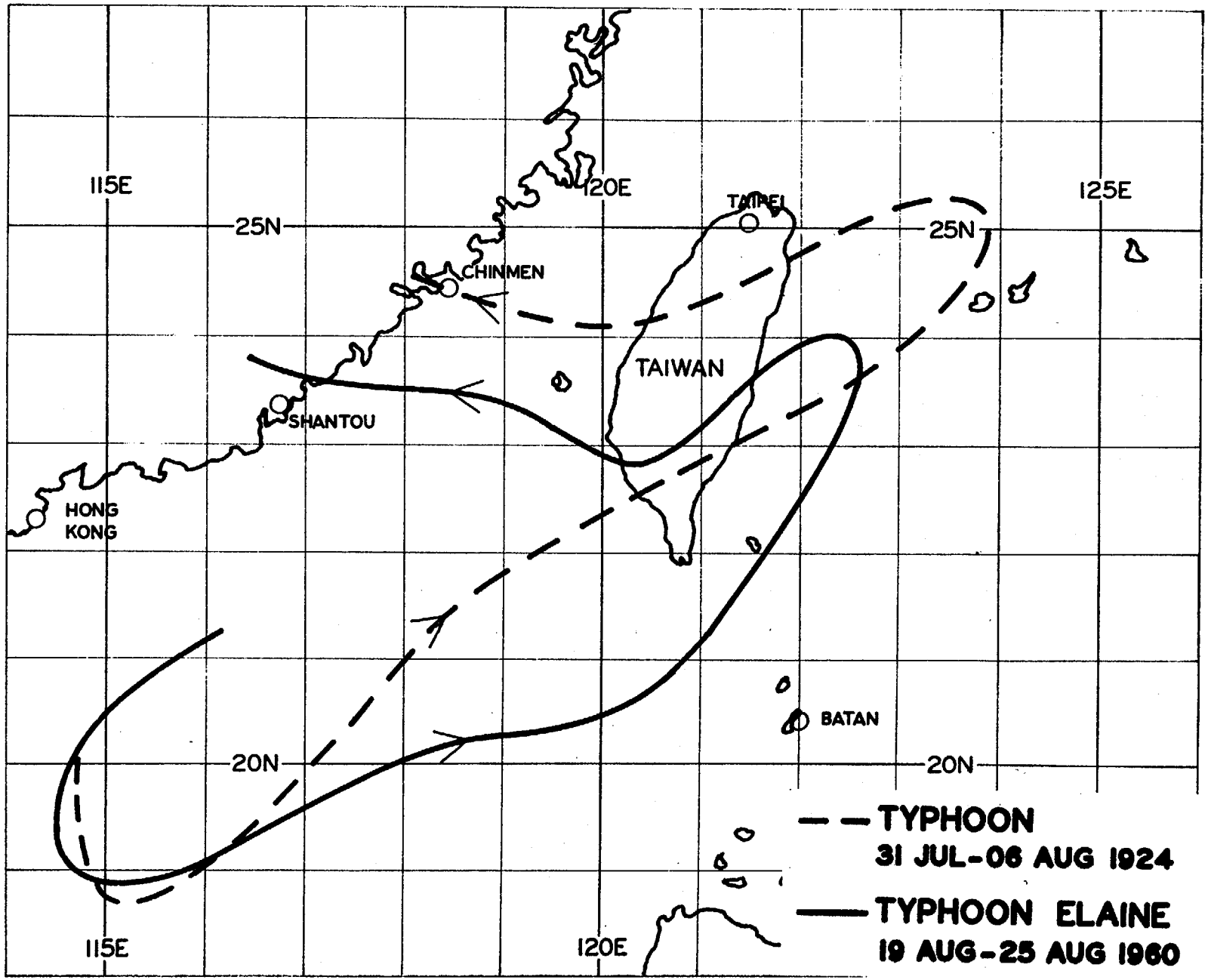
*TROPICAL STORM

1960 TYPHOON FORECAST ERRORS
(IN MI)

TYPHOON	24 HR FORECASTS NO. OF CASES	24 HR FORECASTS MEAN ERROR	48 HR FORECASTS NO. OF CASES	48 HR FORECASTS MEAN ERROR
KAREN	5	114	1	284
*LUCILLE	6	206	2	594
MARY	31	148	27	349
*NADINE	16	104	12	196
OLIVE	20	127	16	218
POLLY	37	85	33	184
SHIRLEY	14	103	10	185
TRIX	21	173	17	436
VIRGINIA	7	308	3	500
WENDY	4	240	0	- -
BESS	14	205	10	480
CARMEN	21	154	17	265
DELLA	37	173	29	361
ELAINE	16	148	12	323
FAYE	30	246	26	505
KIT	32	102	28	174
LOLA	32	148	28	284
MAMIE	19	165	15	327
NINA	9	210	5	247
OPHELIA	30	147	26	323
PHYLLIS	28	157	24	346

*TROPICAL STORM

AVERAGE ERROR-24 HR FORECASTS (429 CASES). 154
AVERAGE ERROR-48 HR FORECASTS (341 CASES). 311


115E
120E
125E
25N
20N
TAIPEI
CHINMEN
SHANTOU
TAIWAN
HONG
KONG
BATAN
TYPHOON
31 JUL-06 AUG 1924
TYPHOON ELAINE
19 AUG-25 AUG 1960

CHAPTER II

OPERATIONAL PROCEDURES

A. DETECTION OF TROPICAL CYCLONES

Surface and upper air analyses, supported by the Stidd Diagram and time cross-sections of winds aloft for the Trust Territory Islands, were the primary means by which tropical cyclones were initially detected. Normally, when reconnaissance aircraft are routinely available for investigative flights and a doubt exists as to whether a circulation is actually closed, the initial warning is not issued until an investigation has been made which confirms the existence of a vortex. Due to the fact that reconnaissance aircraft were frequently not available for investigative flights during 1960, it was often necessary to issue an initial warning based on only a few surface and/or upper air observations which indicated the possible existence of a tropical cyclone. Of the 19 typhoons and 2 tropical storms described in detail in this Report, initial warnings were based primarily on ship reports in 11 cases, on the Stidd Diagram and time cross-sections of the winds aloft in 6 cases, aircraft reports (other than reconnaissance) in 2 cases, land reports in 1 case, and observations from a scheduled reconnaissance flight in 1 case. Because of the increased availability of reconnaissance aircraft during 1961, the detection of tropical cyclones should take place earlier in the formative stages of their development, and initial warnings will, in most cases, be based on reconnaissance.

B. WARNINGS

Warnings are filed and transmitted every 6 hours at synoptic times (0000Z, 0600Z, etc.), the present position of the tropical cyclone, as contained in the warning, being valid for the scheduled transmission time. Therefore, the "present position" of a tropical cyclone is actually a short range forecast position. The position may be based on a reconnaissance fix 30 minutes to perhaps 6 hours old, on surface observations as much as 6 hours old, etc. It is for this reason that the 0600Z warning, for example, may not, on occasions, agree with the position of the tropical cyclone as indicated by the 0600Z analysis. Amendments are issued when the difference is significant. The numbers of tropical warnings run consecutively when the cyclone is upgraded or downgraded, and if warnings are discontinued and the circulation regenerates, the new series of warnings are numbered consecutively from the number of the last warning of the previous series. When necessary, amendments and corrections are issued, and these are numbered the same

as the warning which they amend or correct.

C. COORDINATION WITH OTHER AGENCIES

Coordination with other agencies is on a scheduled and unscheduled basis. When a circulation, for which warnings are being issued, is N of approximately 20N, Fuchu Air Force Weather Central transmits scheduled coordination forecasts twice daily to FWC/JTWC. These forecasts are based on the 500 mb space mean technique. Coordination with other Air Force and Navy activities is on an unscheduled basis depending upon the existing situation.

D. VERIFICATION OF 24 AND 48 HOUR FORECASTS

All 24 and 48 hour forecasts, made when a tropical cyclone is of tropical storm or typhoon intensity, are verified when the verifying position, based on the best track, is at or S of 35N.

A table is included in Chapter I of this Report showing the average error for each 1960 typhoon and for Tropical Storms LUCILLE AND NADINE. In addition, Chapter V contains a Table of "Position and Forecast Verification Data", in each individual typhoon summary. In each of these Tables the 24 and 48 hour forecast errors are the errors of the forecasts which were made 24 and 48 hours previous to the date-time group. For example, the 24 and 48 hour forecast errors shown for 211200Z are the errors of the forecasts made at 201200Z and 191200Z, respectively. Also included in each individual typhoon summary is a chart showing the 24 hour forecast position in relation to the best track position.

CHAPTER III

RECONNAISSANCE

AIRCRAFT WEATHER RECONNAISSANCE

Typhoon forecasting and tropical weather reconnaissance go hand in hand and, in the forseeable future, it is believed unlikely that good forecasts will be made without aircraft reconnaissance.

During 1960 the most significant change that took place with respect to reconnaissance units in the western Pacific was the deactivation of the 54th WRS in March. The 54th arrived at Andersen AFB, Guam in the summer of 1947, and flew tropical cyclone reconnaissance for a period of 13 years. Upon the deactivation of the 54th, the mission of tropical cyclone reconnaissance was assigned to the 56th WRS at Yokota AB, Japan. The 56th is presently under the command of LT COL E.D. Wallace. Simultaneously with the deactivation of the 54th, Detachment 1 of the 56th was activated at Andersen AFB.

The only significant problem (and it was truly a major problem), having to do with reconnaissance during 1960, was the grounding in early May of all except one of the WB-50 aircraft of the 56th. The grounding was ordered so as to make a complete inspection of all fuel cells and to effect necessary repairs and/or replacement. To provide for tropical cyclone reconnaissance during the interim the WB-50s were to be grounded, the Commander 1st Weather Wing requested the assistance of PACAF. CINCPAC in turn approved PACAF's request for 970 flying hours for tropical storm and typhoon reconnaissance. The aircraft selected for use was the C-130, a cargo type aircraft adaptable to this task. The aircraft were provided by the 315th Air Division with Headquarters at Tachikawa AB, Japan. The 56th WRS furnished a crew member with dual qualifications of navigator - weather observer to supplement the 315th AD crews for each mission. During the period 11 June through 13 September the 315 AD flew a total of 38 tropical cyclone sorties. By mid-September the 56th WRS had in-commission aircraft in a number sufficient to justify the relief of the 315th AD from any further tropical cyclone reconnaissance. The fine support provided by the 315th AD was commendable, particularly since few, if any, of the crews had prior experience in tropical cyclone reconnaissance.

Filling in the breech throughout the Typhoon Season, and doing an outstanding job, was the VW-1 Squadron, Agana NAS, Guam, commanded by Captain C.G. Strum. In addition to making many night radar fixes on typhoons, VW-1 also flew a number of investigations on suspect areas which

could not be flown by the 56th due to the shortage of aircraft (discussed in the foregoing paragraph). During the year VW-1 flew 57 sorties, while other Seventh Fleet units flew an additional 10 sorties.

In spite of the critical shortage of in-commission aircraft during the Typhoon Season, the reconnaissance provided by the 56th WRS was considered excellent. This is evidenced by the fact that for the 6 month period beginning 1 July, the 56th (augmented by the 315th AD until mid-September) met 90 percent of all tropical storm and typhoon requirements leveled by the JTWC. In order to satisfy these requirements, with the limited resources available, the 56th was able to provide only limited reconnaissance on suspect areas and tropical depressions.

The Table, "Sortie - Fix/Investigation Data", in this chapter provides considerable information concerning reconnaissance during the 1960 Season. It should be noted that, with but one exception, the data is for the period 1 July through 31 December. This is because "Requirements versus Fulfilments" data for the period prior to 1 July would have little meaning, since it was not until early July that the 56th WRS had the capability of partially meeting normal tropical cyclone reconnaissance requirements. VW-1 requirements were fulfiled in each case, however no requests were made when aircraft were not available for weather reconnaissance, a situation that existed on several occasions due to other commitments. For this reason "Levied" and "Made/Levied" figures were not presented for USN aircraft.

The 56 WRS normally performed all tropical cyclone reconnaissance at the 700 mb level. The C-130 aircraft usually flew to the tropical cyclone at best cruising altitude (18,000 to 25,000 ft), descended to the 700 mb level, made the fix, and then returned to best cruising altitude. VW-1 aircraft flew most investigations at 500 to 1,500 ft and made most radar fixes on typhoons at 6,000 ft. It is planned that most flights and fixes during 1961 will be made at the 700 mb level.

During 1960, as in the past, the WB-50 aircraft were instrumented with sensitive altimeters, thermometers, radar wind measuring equipment and other meteorological devices. This same equipment will continue to be used in 1961. The C-130 aircraft were not specifically instrumented for weather reconnaissance. Although radio altimeters and radar were available aboard the aircraft, accurate radar wind measuring equipment was not available. The WV-2 aircraft flown by VW-1 were especially well adapted

for fixing typhoons by radar. These aircraft are being equipped for the 1961 Season with the Aerograph Set, AN/AMQ-8, containing temperature, relative humidity, and pressure measuring instruments, the Aircraft Reconnaissance Aneroid Barometer, ML-401/U, and the Aircraft Psychrometer, ML-313/AM.

The TIROS Project promises many advances in the field of tropical meteorology in coming years. The satellite is now capable of initially detecting tropical cyclones, and also of positioning such circulations with sufficient accuracy so that reconnaissance aircraft can be sent directly to the cyclone. At this time, however, it does not appear that the intensity of tropical cyclones can be determined from TIROS photographs with the degree of accuracy required to meet existing operational requirements. Since meteorological satellites will cover areas of the western Pacific which are at present often void of weather observations, earlier detection of tropical cyclones can be expected in the future.

The outlook with regard to tropical cyclone reconnaissance during the 1961 Typhoon Season is bright. All aircraft of the 56th WRS are again flyable, and the crews are "standing by" for the first typhoon of the year. The VW-1 Squadron will provide considerably more reconnaissance than during the past several years. In addition to making night radar fixes on all fully developed typhoons, VW-1 will also make tropical cyclone investigative flights in the area west of Guam and south of 20N.

SORTIE - FIX/INVESTIGATION DATA

1. TROPICAL CYCLONE SORTIES BY SERVICE:

	1959	1960
USAF	320 (98%)	241 (78%)
USN	6 (2%)	67 (22%)
TOTAL	326	308

2. TROPICAL CYCLONE SORTIES BY UNIT (01 JULY - 31 DEC 1960)

56TH WEARON	182 (67%)
(*) 315TH AIR DIV	33 (12%)
VW-1	53 (20%)
OTHER USN	2 (1%)
TOTAL	270

3. FIX/INVESTIGATION REQUIREMENTS VS FULFILMENT (01 JULY-31 DEC 1960)

a. ALL CYCLONES

	USAF	USN
LEVIED	328	
MADE	262	49
MADE/LEVIED	80%	

b. TYPHOONS & TROPICAL STORMS ONLY

	USAF	USN
LEVIED	267	
MADE	239	35
MADE/LEVIED	90%	

c. INVESTIGATIONS & TROPICAL DEPRESSIONS ONLY

	USAF	USN
LEVIED	61	
MADE	23	14
MADE/LEVIED	38%	

(*) LAST CYCLONE MISSION BY 315TH AIR DIV FLOWN ON 13 SEPT 1960

CHAPTER IV

FORECAST TECHNIQUES

A. GENERAL

The question, "How do you forecast typhoons?", is frequently asked by personnel who make operational decisions based on our warnings, as well as by meteorologists who have had little or no experience in tropical cyclone forecasting. The simplest answer is that all pertinent data, including that gleaned from current and prognostic surface and upper air charts and differential analyses, is combined subjectively to produce each warning. This would indicate that the art of tropical forecasting is perhaps less advanced than the art of forcasting in temperate or northern latitudes.

After the initial detection of a tropical cyclone, the forecast problems are: direction of movement, speed of movement, intensification, and weakening. In the case of weakening, the problem usually relates to whether the cyclone will weaken and become extratropical, or weaken and dissipate.

As a tool in preparing our forecasts, a basic chart (from the Pacific Airways Plotting Chart series) plus 3 acetate overlays are used. All fixes are plotted on the basic chart. Twenty-four hour forecast positions are plotted on the bottom overlay, warning positions (later modified when necessary) are plotted on the second overlay, and the top overlay is utilized as a work sheet.

B. FORECASTING MOVEMENT

Once a tropical cyclone has been detected, the first step in preparing to issue the initial warning is to lay out a track based on climatology. This track is laid out on the top acetate so as to extend 4 or 5 days at the speed indicated by climatology. Next, the track is modified in accordance with the existing and forecast upper air pattern, after which the initial warning is prepared and issued. The forecast track is extended and modified with time, as reconnaissance fixes are received and the upper air pattern changes.

Once a typhoon has reached typhoon intensity, reconnaissance fixes are the primary data used in preparing forecasts for the subsequent 24 hours. At this stage of development, prior reconnaissance fixes have usually established a fairly well-defined track, and acceleration or deceleration trends can be determined from an evaluation of the fixes received during the previous 24 hours.

Used as supplementary tools in preparing the 12 and 24 hour forecasts are the Miller-Moore objective method, surface and upper air analyses and prognoses, differential analyses, and height and pressure change charts.

Forecasts for the second 24 hour period (the 48 hour forecast), for which we admittedly have a low level of skill, are based to a large degree on upper air prognoses and differential analyses.

The large triangle formed by Guam, Manila and Tokyo describes the preferred area for tropical cyclone recurvature. The sparsity of upper air data in this area frequently precludes accurate analyses. This of course makes it extremely difficult to determine, within desirable limits of accuracy, the latitude of recurvature, or the shape of the recurvature pattern. The single and double 500 mb space mean charts are sometimes an aid in determining the forecast direction of movement of a typhoon during the critical period of recurvature.

After recurvature, a typhoon or tropical storm behaves in a manner similar to an extratropical cyclone regarding movement, and it is therefore necessary to carefully consider the movement, slope and change in shape of the major upper air systems during this period. After recurvature, reconnaissance fixes continue to be the most important forecasting tool. In addition, the 500 mb double space mean plus M2 field has been found to be very useful.

As typhoons approach land masses, direction of movement is frequently modified. At times, ridging develops between the typhoon and terrain and, in the case of Japan, this causes a typhoon S of Japan and moving to the NE, to move slightly more easterly. Typhoons approaching and passing over Taiwan undergo complex changes in movement, configuration and intensity.

C. INTENSIFICATION AND WEAKENING

Those tropical cyclones which subsequently reach typhoon intensity, usually intensify from a tropical depression, with surface winds of 20 to 25 kts, to typhoon strength in a period of about 3 days. The development of wall clouds appears to be the critical factor involved. A tropical cyclone frequently develops to storm intensity with a fairly haphazard cloud pattern, i.e., no well developed spiral bands exist, and unstable clouds are frequently found near the center but are not organized.

The key to intensification to typhoon strength appears to be the organization of a wall cloud system along with spiral bands. Once this occurs, the cyclone appears to be an energy generator, and is limited in intensity only by the raw material source (warm moist air from over an extensive warm water surface) and by the ability of the external environment to dispose of this energy.

Forecasting changes in intensity is accomplished by use of reconnaissance observations to determine existing conditions, followed by an evaluation of the high level pattern to determine whether intensification or weakening is indicated. Needless to say, the passage of a typhoon over a large land mass or cold water, or the transport of cold air in the lower levels into a typhoon circulation, will cause the system to weaken. The typical sequence of intensification - weakening is essentially as follows: intensification to typhoon strength, continued intensification until recurvature is completed, then slow weakening as the system passes through a less favorable environment until it becomes extratropical.

CHAPTER V

INDIVIDUAL 1960 TYPHOONS

A. TYPHOON KAREN (220000Z-251800Z APRIL 1960)

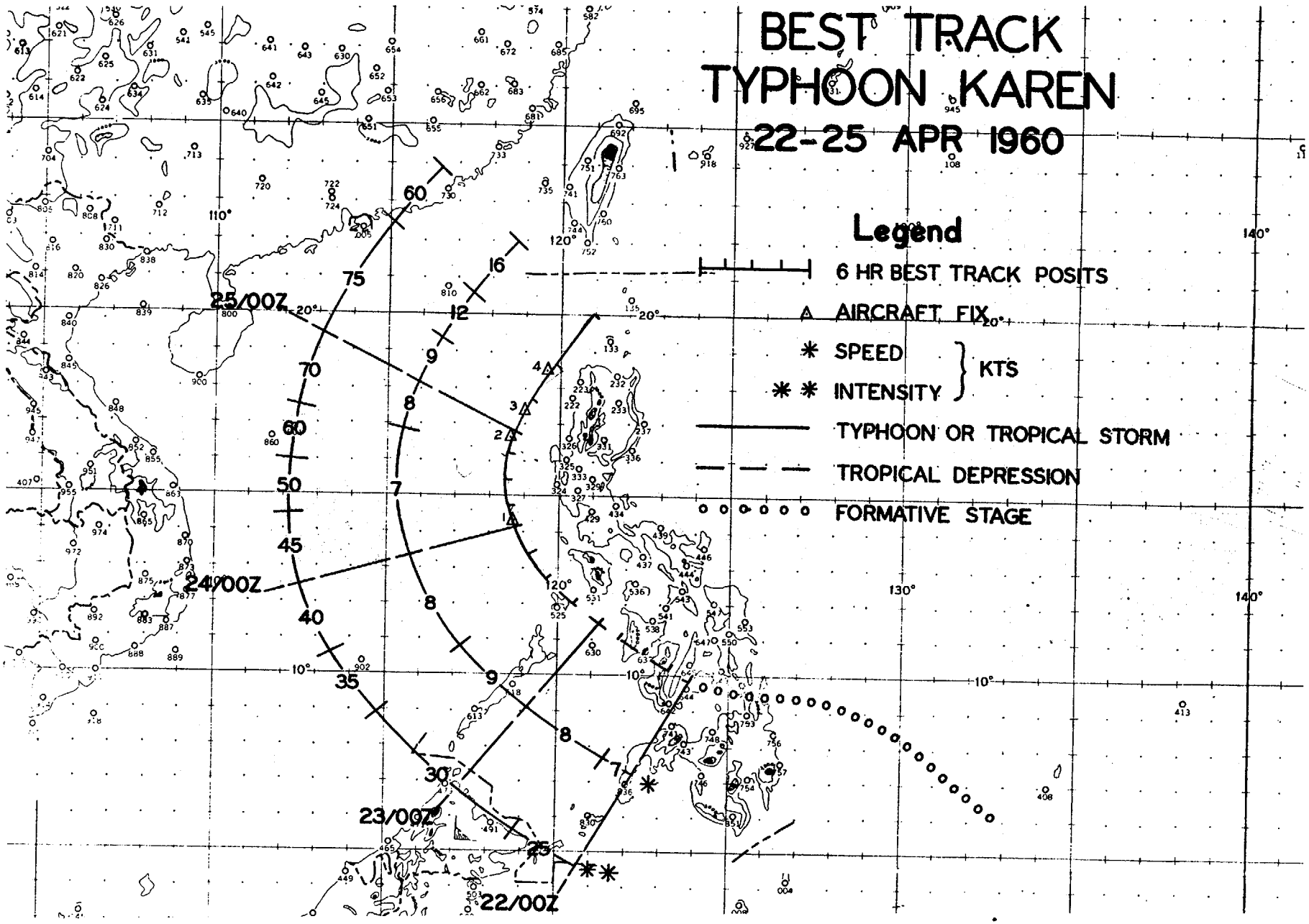
On 13 April, 9 days before the first warning was issued, TIROS I indicated an area of cloudiness in the vicinity of 5N 145E. Subsequent surface charts confirmed the existence of a cyclonic circulation in this area. This cyclone moved slowly W, passed S of Koror, and approached the Philippines. Insufficient data made accurate analysis difficult, but center pressures were believed to be no lower than 1005MB and maximum winds not greater than 20 kts. By 211200Z the cyclone was moving over the Philippines, and reports indicated that it was intensifying. Warning number 1 was issued at 220000Z on T. D. KAREN, at which time the cyclone was located slightly east of Cebu in the Southern Philippines.

KAREN intensified, moved NW, and passed 120 miles SW of Manila. The diameter of the storm remained very small, and sparse surface reports did not indicate that KAREN was of typhoon intensity. However, on the basis of reconnaissance, KAREN was upgraded to a typhoon at 241800Z. The typhoon then weakened as it recurved; and at 251200Z it was downgraded to a tropical storm and 6 hours later the final warning was issued.

Typhoon KAREN will probably be known in meteorological history as a "baby" typhoon since it had an eye diameter averaging only 10 mi. The radius of 50 kt surface winds never exceeded 30 mi, and the radius of 30 kt winds did not exceed 75 mi. This fact probably accounts for the rapid demise in spite of the large area of warm air surrounding the typhoon. This type of typhoon is characteristic of those intensifying off the W coast of the Philippines, but seldom are they tracked for such a distance to the E before intensifying into a typhoon. Without reconnaissance, it is quite probable that KAREN would never have been identified as a tropical circulation of typhoon intensity. Available surface reports show maximum surface winds of only 35 kts.

Sixteen warnings were issued covering a period of 3 days and 18 hours. KAREN traveled 800 mi at an average speed of 9 kts or 211 mi per day. The minimum speed was 7 kts on 24 April, and the maximum speed of 16 kts was achieved on 25 April.

Based on the winds aloft at Clark AB, the typhoon extended through the 300 mb level as a closed circulation when NW of that station at 241200Z.


BEST TRACK
TYPHOON KAREN
22-25 APR 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
25/00Z
24/00Z
23/00Z
22/00Z
110°
120°
130°
140°
20°
10°

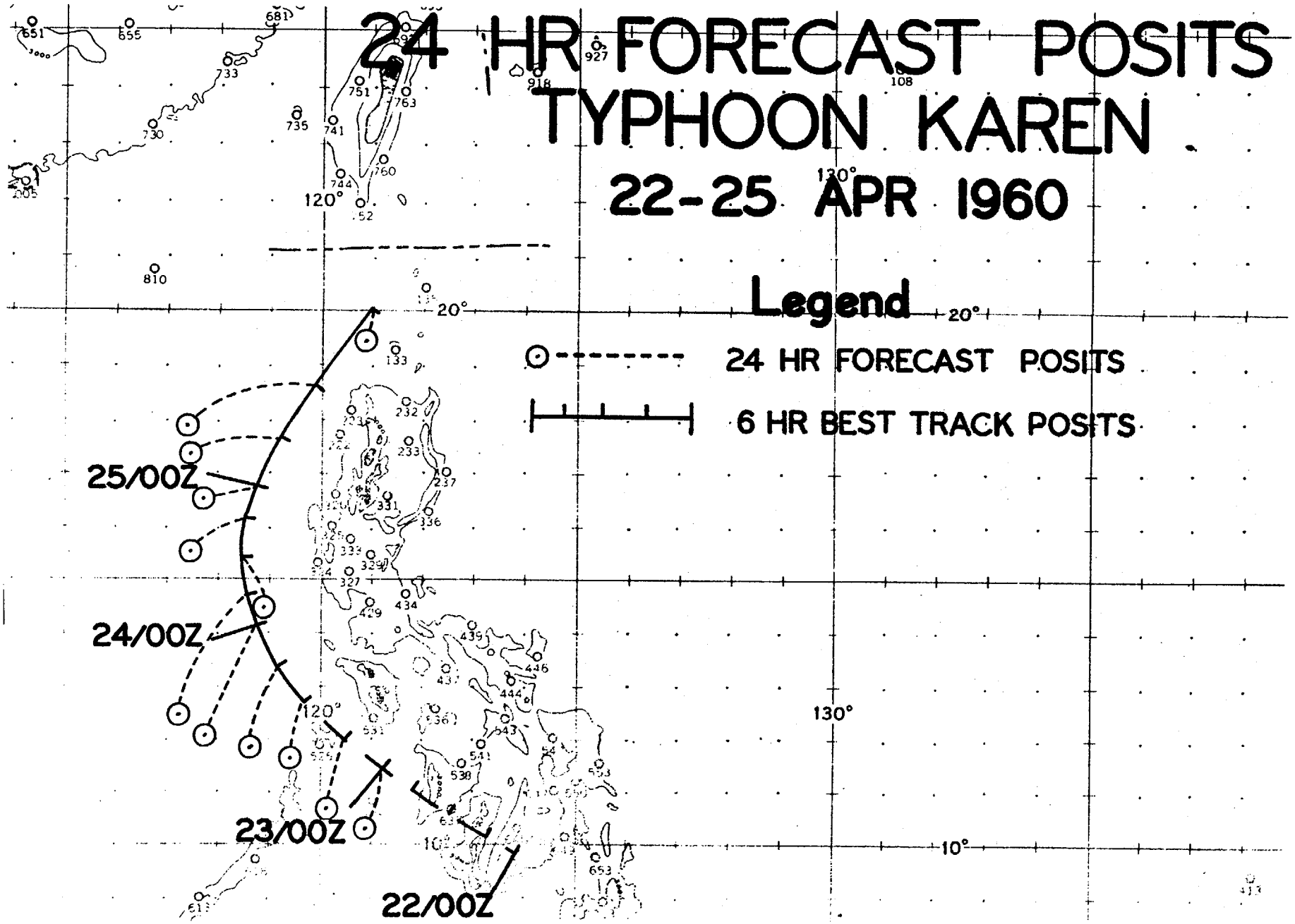
RECONNAISSANCE AIRCRAFT FIXES - TYPHOON KAREN

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	240100Z	14.2N	118.7E	56-P-05	996	45	10080 (998)	45	15/08	CIRC DIA 10 MI
2	242300Z	16.7N	118.8E	56-P-05	991	75	9980 (995)	60	18/10	CIRC DIA 08 MI
3	250300Z	17.3N	119.0E	56-P-05	988	75	9940 (993)	70	16/09	CIRC DIA 08 MI
4	251010Z	18.5N	119.7E	56-P- U	998	60	10140	50	17/11	SEMI-CIRC DIA 18 MI OPEN S

TYPHOON KAREN 22-25 APRIL 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
220000Z	09.8N	123.8E	- - - -		- - - -	
220600Z	10.1N	123.2E	- - - -		- - - -	
221200Z	10.5N	122.4E	- - - -		- - - -	
221800Z	11.0N	121.8E	- - - -		- - - -	
230000Z	11.5N	121.1E	- - - -		- - - -	
230600Z	12.1N	120.4E	- - - -		- - - -	
231200Z	12.7N	119.7E	- - - -		- - - -	
231800Z	13.4N	119.2E	- - - -		- - - -	
240000Z	14.1N	118.8E	- - - -		- - - -	
240600Z	14.7N	118.6E	- - - -		- - - -	
241200Z	15.4N	118.5E	- - - -		- - - -	
241800Z	16.1N	118.6E	250	77	- - - -	
250000Z	16.9N	118.8E	253	65	- - - -	
250600Z	17.7N	119.2E	252	105	- - - -	
251200Z	18.8N	119.9E	250	157	- - - -	
251800Z	20.0N	121.0E	245	168	242	284

AVERAGE 24 HOUR ERROR 114 MI
AVERAGE 48 HOUR ERROR 284 MI

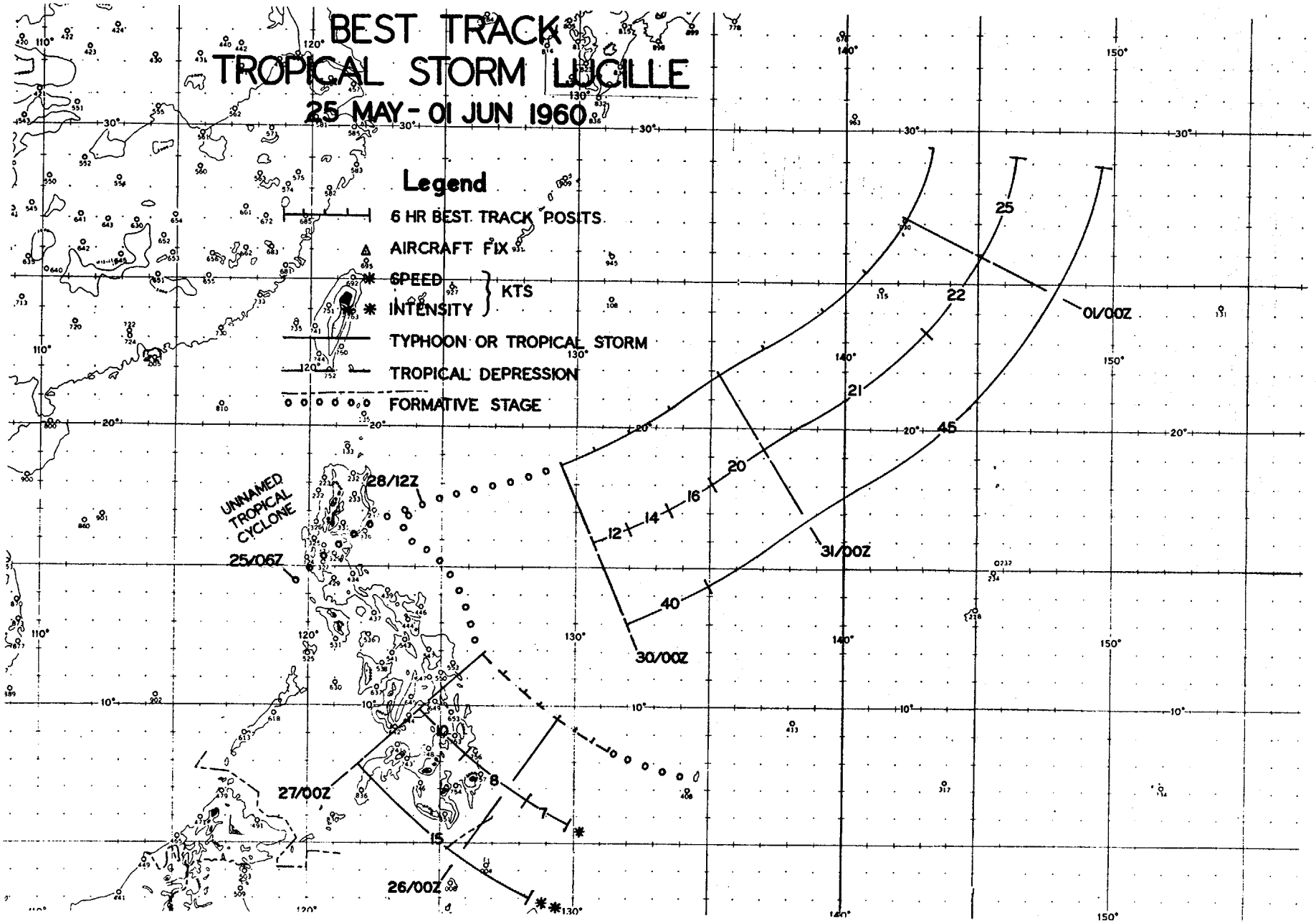

24 HR FORECAST POSITS
TYPHOON KAREN
22-25 APR 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
25/00Z
24/00Z
23/00Z
22/00Z
120°
130°
20°
10°

B. TROPICAL STORM LUCILLE (250600Z MAY-010600Z JUNE 1960)

The 240600Z surface chart indicated the possible existence of a cyclonic circulation W of Koror. Twenty-four hours later the first warning was issued on T.D. LUCILLE. Also, at this time an elongated, unnamed low developed NW of Manila. LUCILLE moved W at 7 kts for the first 12 hours, but then turned NW and began to accelerate. At 270000Z the final warning was issued because the maximum winds around this depression had decreased to only 15 kts. During this time the low over NW Luzon had remained quasistationary.

The unnamed low began to move NE at 280000Z, and the Clark AB rawin indicated that this system was a closed cyclonic circulation at 500 mb. As this low crossed the Philippines the highest reported surface winds were 34 kts, reported in the Manila area. This unnamed low merged with the circulation that had been T.D. LUCILLE, and the merged system moved NE. At 300000Z, warnings on LUCILLE were renewed, this time as a tropical storm. LUCILLE, with center wind speeds of 45 kts, accelerated as it moved NE and passed 40 mi W of Iwo Jima at 311700Z. The strongest surface winds at Iwo Jima were 30 kts with gusts to 45 kts. The storm then passed within 10 mi of Peel Island at 312330Z. This island experienced a minimum SLP of 992 mb and winds of 50 kts with gusts to 70 kts, which caused the USS Cayuga County (LST) to broach in the harbor. The high wind speeds experienced at Peel Island are not considered representative, and are believed to be 30 to 40 percent higher than representative winds due to the "funneling" effect of the terrain to the SSW of the harbor. The winds abruptly decreased once LUCILLE passed the island. As the storm continued to move NE it accelerated and rapidly became extratropical. The final tropical warning was issued at 010600Z.

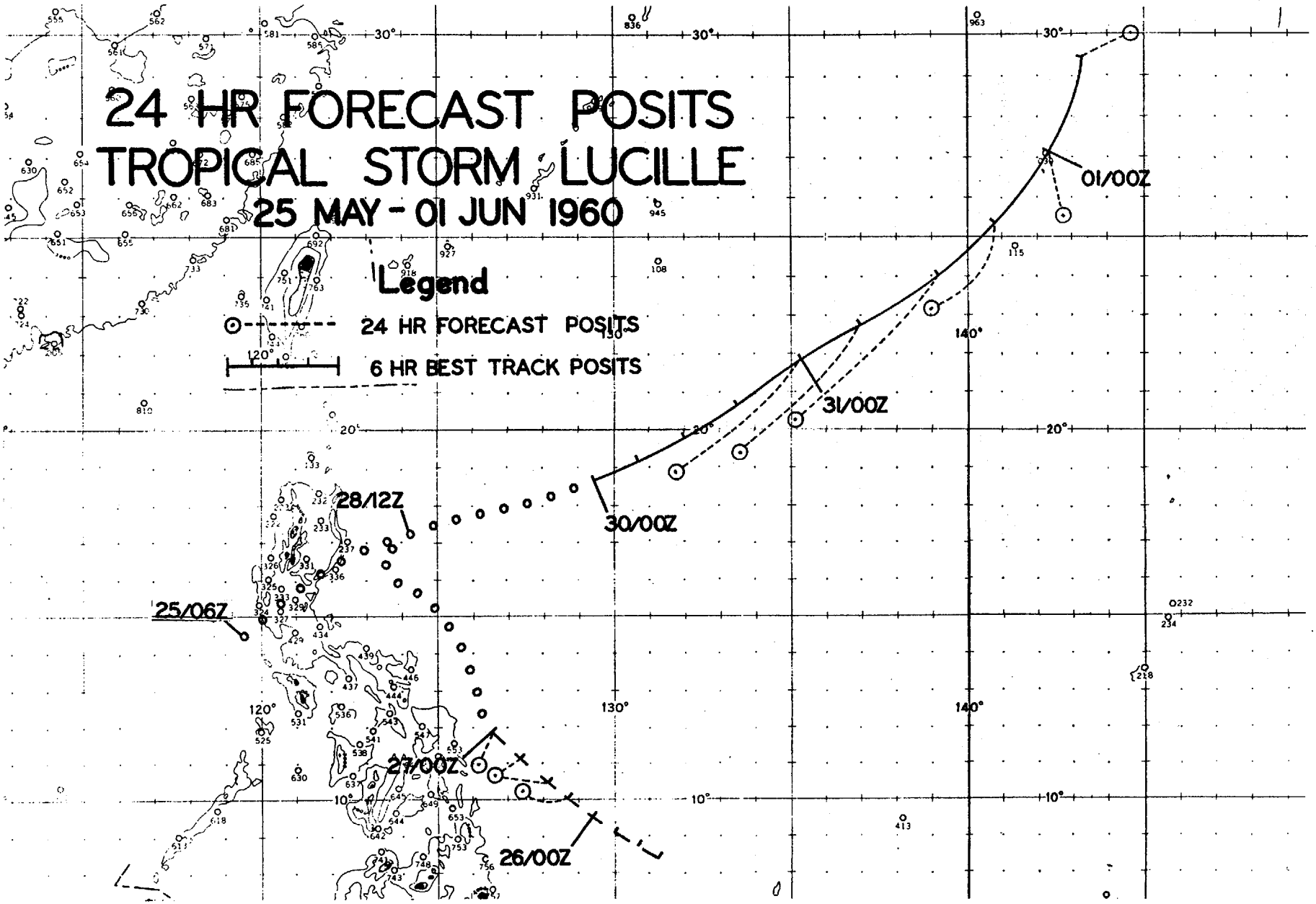
Eighteen warnings were issued on LUCILLE covering two periods. During the first period (250600Z-270000Z) LUCILLE traveled 350 mi in 1 day and 18 hours, averaging 8 kts or 199 mi per day. During the second period (300000Z-010600Z) LUCILLE traveled 1,050 mi in 2 days and 6 hours, averaging 19 kts or 459 mi per day. The minimum speed was 7 kts on 25 May, and the maximum speed was 25 kts on 1 June.


BEST TRACK
TROPICAL STORM LUCILLE
25 MAY - 01 JUN 1960
Legend
6 HR BEST TRACK POSITS.
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
UNNAMED TROPICAL CYCLONE
25/06Z
28/12Z
27/00Z
26/00Z
30/00Z
31/00Z
01/00Z
12
14
16
20
21
22
25
40
45
8
10
15

TROPICAL STORM LUCILLE 25 MAY-01 JUNE 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
250600Z	08.4N	131.3E	- - - -	- - - -
251200Z	08.7N	130.7E	- - - -	- - - -
251800Z	09.1N	130.1E	- - - -	- - - -
260000Z	09.5N	129.4E	- - - -	- - - -
260600Z	10.0N	128.8E	- - - -	- - - -
261200Z	10.5N	128.1E	- - - -	- - - -
261800Z	11.1N	127.4E	- - - -	- - - -
270000Z	11.9N	126.7E	- - - -	- - - -
270000Z TO 300000Z NO WARNINGS ISSUED				
300000Z	18.7N	129.5E	- - - -	- - - -
300600Z	19.2N	130.7E	- - - -	- - - -
301200Z	19.8N	132.0E	- - - -	- - - -
301800Z	20.7N	133.5E	- - - -	- - - -
310000Z	21.9N	135.2E	225-264	- - - -
310600Z	23.0N	137.1E	221-295	- - - -
311200Z	24.0N	139.1E	223-319	- - - -
311800Z	25.3N	140.9E	218-168	- - - -
010000Z	27.2N	142.1E	162-116	221-582
010600Z	29.5N	143.3E	067-077	211-606

AVERAGE 24 HOUR ERROR 206 MI
AVERAGE 48 HOUR ERROR 594 MI

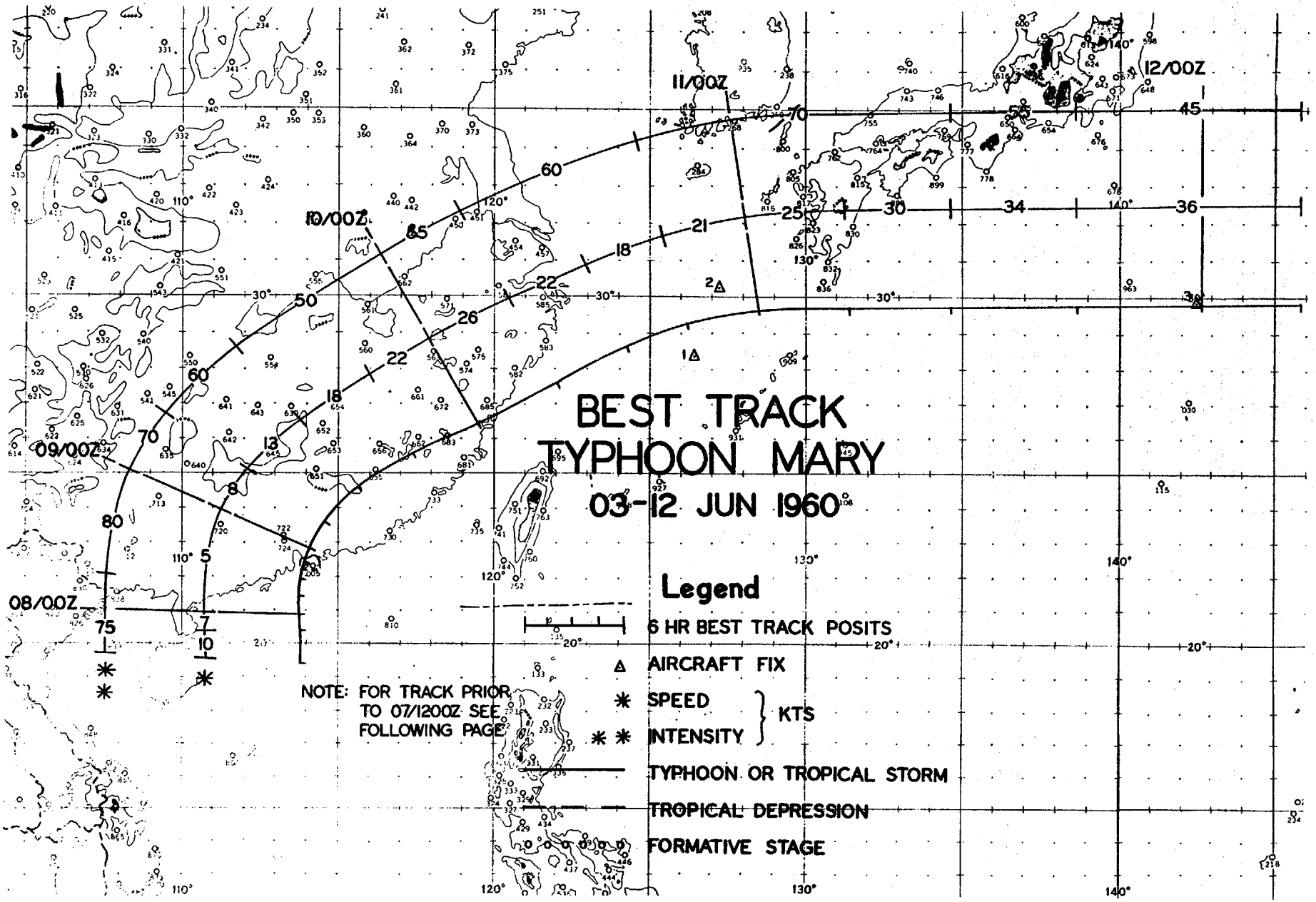

24 HR FORECAST POSITS
TROPICAL STORM LUCILLE
25 MAY - 01 JUN 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
120°
25/06Z
28/12Z
30/00Z
31/00Z
01/00Z
27/00Z
26/00Z
30°
20°
10°
120°
130°
140°

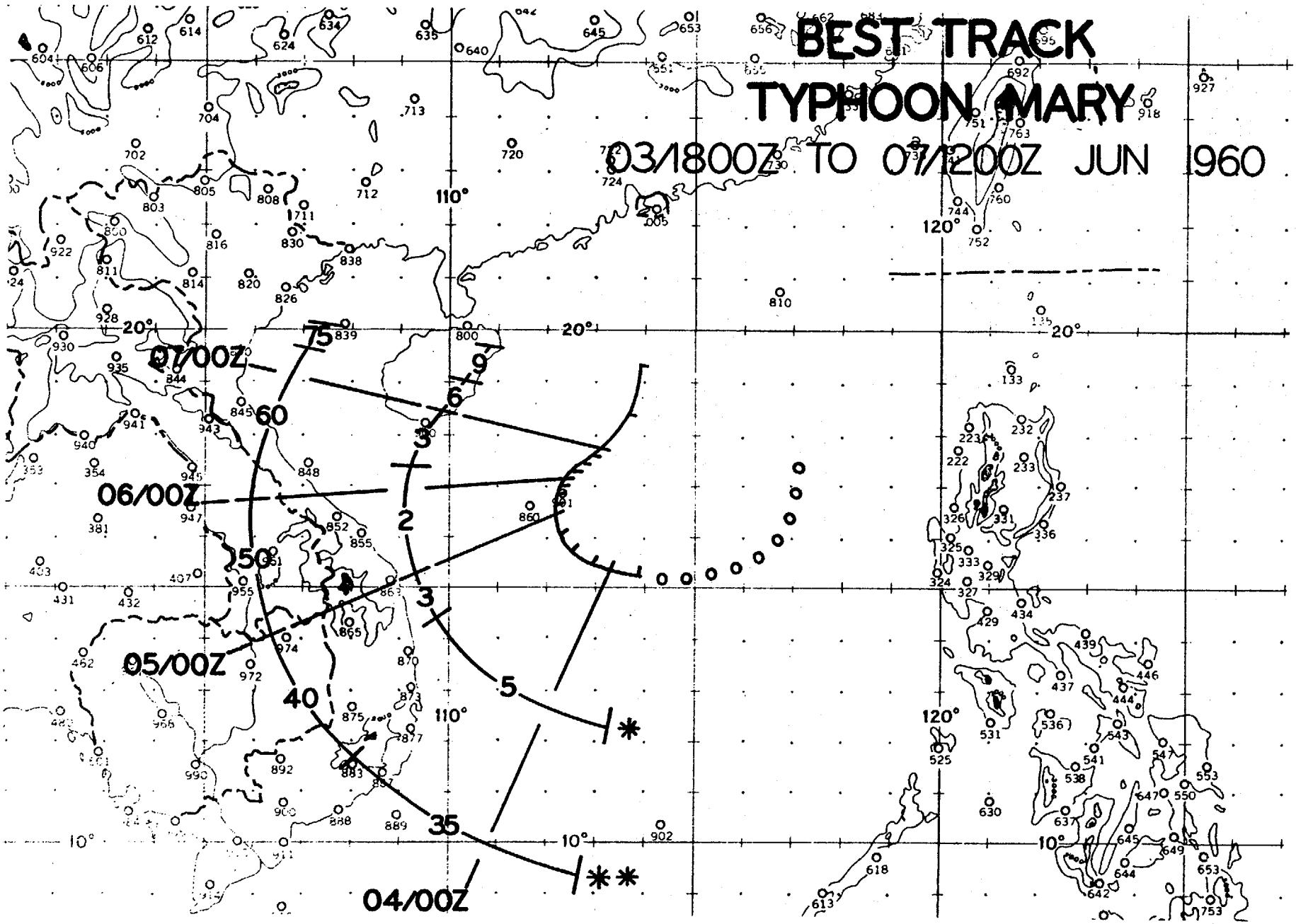
C. TYPHOON MARY (031800Z-120600Z JUNE 1960)

MARY, better known as "Bloody Mary", performed in a typically feminine manner; however, not as a typical typhoon. A trough of low pressure, oriented NE to SW, lay off the E coast of Taiwan for several days, and slowly extended into the South China Sea. By 020000Z a weak circulation was evident at the extreme SW portion of this trough in the South China Sea, about 200 mi W of northern Luzon. During this time a wind maximum of 30 kts had formed at 3000 ft at 9N, from a point W of 100E, to 115E. By 031200Z this wind maximum had moved to a position such that it appeared to be feeding into MARY from the S and W. The maximum winds then appeared to be 150 to 200 mi to the S amd W of the low center. The first warning was issued on MARY as a storm at 031800Z. Its position was near 15N 114E, with maximum winds of 35 kts from the E through the SW, 150 to 250 mi from the center, and with an observed low pressure of 996 mb. MARY appeared to be moving W at 6 kts. The low continued to intensify and turn slowly to the NW, and then N after 041800Z. From 041800Z to 061800Z the average speed was only 2 or 3 kts and the wind speeds increased to 60 kts. After 061800Z the low moved N toward Hong Kong at an average speed of 7 kts with surface winds of 60 kts or more. It probably became a typhoon between 070000Z and 071200Z. Typhoon MARY passed less than 20 mi to the W of Hong Kong between 081200Z and 081800Z. It was at this time that the appellation "Bloody" was attached (see damage report in Chapter 6). Over land this typhoon rapidly decreased in intensity to 50 kts, increased in speed from an average of 7 to 26 kts by 100600Z, and moved in a NE direction from 090600Z to 101800Z. Between 101200Z and 101800Z the low intensified into a typhoon again with winds of 70 kts or more. Now moving E, MARY passed 170 mi N of Okinawa, 70 mi S of Kyushu and continued E, increasing to a speed of 36 kts by 111800Z. The typhoon decreased to tropical storm intensity by 111800Z and it became extratropical by 120600Z when the final warning was issued.

MARY traveled 2400 mi during the 8 and one half days that warnings were issued, at an average speed of 12 kts or 284 mi per day. The minimum speed was 2 kts 5-6 June, and the maximum speed was 36 kts on 12 June. The typhoon extended through the 200 mb level while in the vicinity of Hong Kong, and moved through the 200 mb ridge from the S to N in that area.

Only 3 reconnaissance fixes were made on MARY, none of the 3 being made in the South China Sea. Therefore, in the interest of a more accurate and complete post-analysis, the following parameters, normally obtained by means of reconnaissance fixes, were computed: minimum sea level pressure, maximum surface wind, minimum 700 mb height, and in some instances, maximum 700 mb wind. The computed values, which are contained in the "Reconnaissance Aircraft Fixes" table, were computed for 1800Z, 3 through 11 June and for 0600Z, 12 June. Surface pressures for MARY as a storm were secured by graphing pressure against distance through two or more stations or ship reports near the low center. At least two such graphs were made for each pressure presented. This presumes a linear pressure decrease toward the center of the storm. Tests of this system on storms with known center values indicated an accuracy of 2 mb. This procedure cannot be used for typhoons. The 700 mb height values during the life of MARY as a storm were computed by the use of tables and WBAN-31A, using the estimated surface temperature and dew point, and the calculated center pressure. Data for that period MARY was a typhoon was secured from the Wachholz graph, discussed in Chapter VII.


BEST TRACK
TYPHOON MARY
03-12 JUN 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
NOTE: FOR TRACK PRIOR TO 07/1200Z SEE FOLLOWING PAGE
08/00Z
09/00Z
10/00Z
11/00Z
12/00Z
110°
120°
130°
140°
20°
30°


BEST TRACK
TYPHOON MARY
03/1800Z TO 07/1200Z JUN 1960
07/00Z
06/00Z
05/00Z
04/00Z
75
60
50
40
35
9
6
3
2
3
5
110°
120°
20°
10°

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON MARY

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
*	031800Z	15.2N	114.0E	CALC	994	35	9928	- -	- - -	- - - - - - - - - - - - - -
*	041800Z	16.2N	112.3E	CALC	990	40	9859	- -	- - -	- - - - - - - - - - - - - -
*	051800Z	16.9N	112.4E	CALC	992	50	9957	- -	- - -	- - - - - - - - - - - - - -
*	061800Z	17.7N	112.9E	CALC	993	60	9964	55	- - -	- - - - - - - - - - - - - -
*	071800Z	20.3N	113.9E	CALC	981	75	9650	70	- - -	- - - - - - - - - - - - - -
*	081800Z	22.5N	114.0E	CALC	975	80	9500	70	- - -	- - - - - - - - - - - - - -
*	091800Z	25.6N	117.2E	CALC	991	50	9879	- -	- - -	- - - - - - - - - - - - - -
1	101416Z	28.3N	126.3E	USN----	- -	60	- - -	- -	- - -	- - - - - - - - - - - - - -
*	101800Z	29.3N	126.1E	CALC	985	70	9525	65	- - -	- - - - - - - - - - - - - -
2	102103Z	30.2N	127.1E	56-P-05	988	65	9590	78	16/10	CIRC NO WALL CLDS
*	111800Z	29.8N	138.7E	CALC	992	55	9787	55	- - -	- - - - - - - - - - - - - -
3	112330Z	29.9N	142.5E	56-P-05	995	35	- - -	- -	- - -	NO WALL CLDS
*	120600Z	29.9N	146.9E	CALC	996	45	9829	- -	- - -	- - - - - - - - - - - - - -

* VARIOUS PARAMETERS CALCULATED DUE TO LACK OF RECONNAISSANCE.

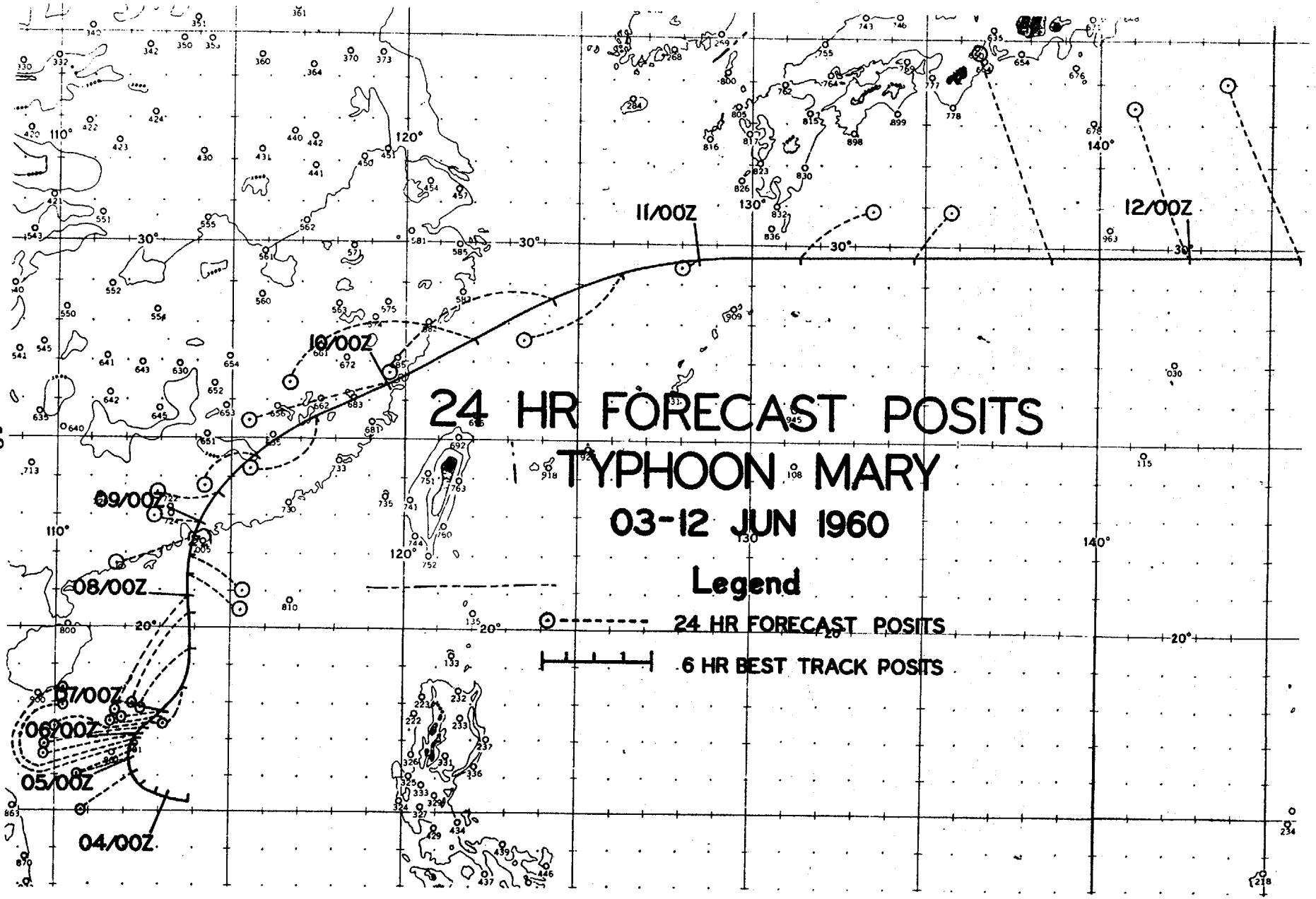
TYPHOON MARY 03-12 JUNE 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
031800Z	15.2N	114.0E	- - - -	- - - -
040000Z	15.3N	113.4E	- - - -	- - - -
040600Z	15.5N	113.0E	- - - -	- - - -
041200Z	15.8N	112.6E	- - - -	- - - -
041800Z	16.1N	112.3E	233-109	- - - -
050000Z	16.4N	112.2E	257-96	- - - -
050600Z	16.6N	112.2E	251-98	- - - -
051200Z	16.8N	112.3E	308-134	- - - -
051800Z	16.9N	112.3E	299-143	258-280
060000Z	17.1N	112.3E	261-149	262-240
060600Z	17.3N	112.5E	262-157	257-228
061200Z	17.5N	112.7E	264-118	292-265
061800Z	17.7N	112.9E	260-165	281-274
070000Z	17.9N	113.1E	238-72	260-315
070600Z	18.5N	113.4E	199-68	257-334
071200Z	19.3N	113.7E	218-122	256-302
071800Z	20.3N	113.9E	216-176	244-382
080000Z	20.9N	113.9E	212-218	208-394
080600Z	21.4N	113.9E	127-93	210-280
081200Z	21.9N	113.9E	127-94	221-305
081800Z	22.4N	113.9E	252-126	214-330
090000Z	22.9N	114.1E	273-68	205-333
090600Z	23.6N	114.6E	265-93	137-167
091200Z	24.6N	115.6E	240-93	134-118
091800Z	25.6N	117.2E	232-133	244-347
100000Z	26.5N	119.4E	253-228	251-377
100600Z	27.6N	122.0E	257-292	252-515
101200Z	28.6N	124.2E	244-283	250-535
101800Z	29.3N	126.1E	236-179	251-505
110000Z	29.7N	128.5E	225-35	259-475
110600Z	29.8N	131.4E	058-120	267-468
111200Z	29.8N	134.8E	048-100	265-525
111800Z	29.8N	138.7E	340-321	268-473
120000Z	29.9N	142.8E	336-231	292-345

TYPHOON MARY 03-12 JUNE 1960
POSITION AND FORECAST VERIFICATION DATA (CONT'D)

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
120600Z	29.9N	146.9E	327-290	002-315

AVERAGE 24 HOUR ERROR 148 MI
AVERAGE 48 HOUR ERROR 349 MI


24 HR FORECAST POSITS
TYPHOON MARY
03-12 JUN 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
04/00Z
05/00Z
06/00Z
07/00Z
08/00Z
09/00Z
10/00Z
11/00Z
12/00Z
110°
120°
130°
140°
30°
20°

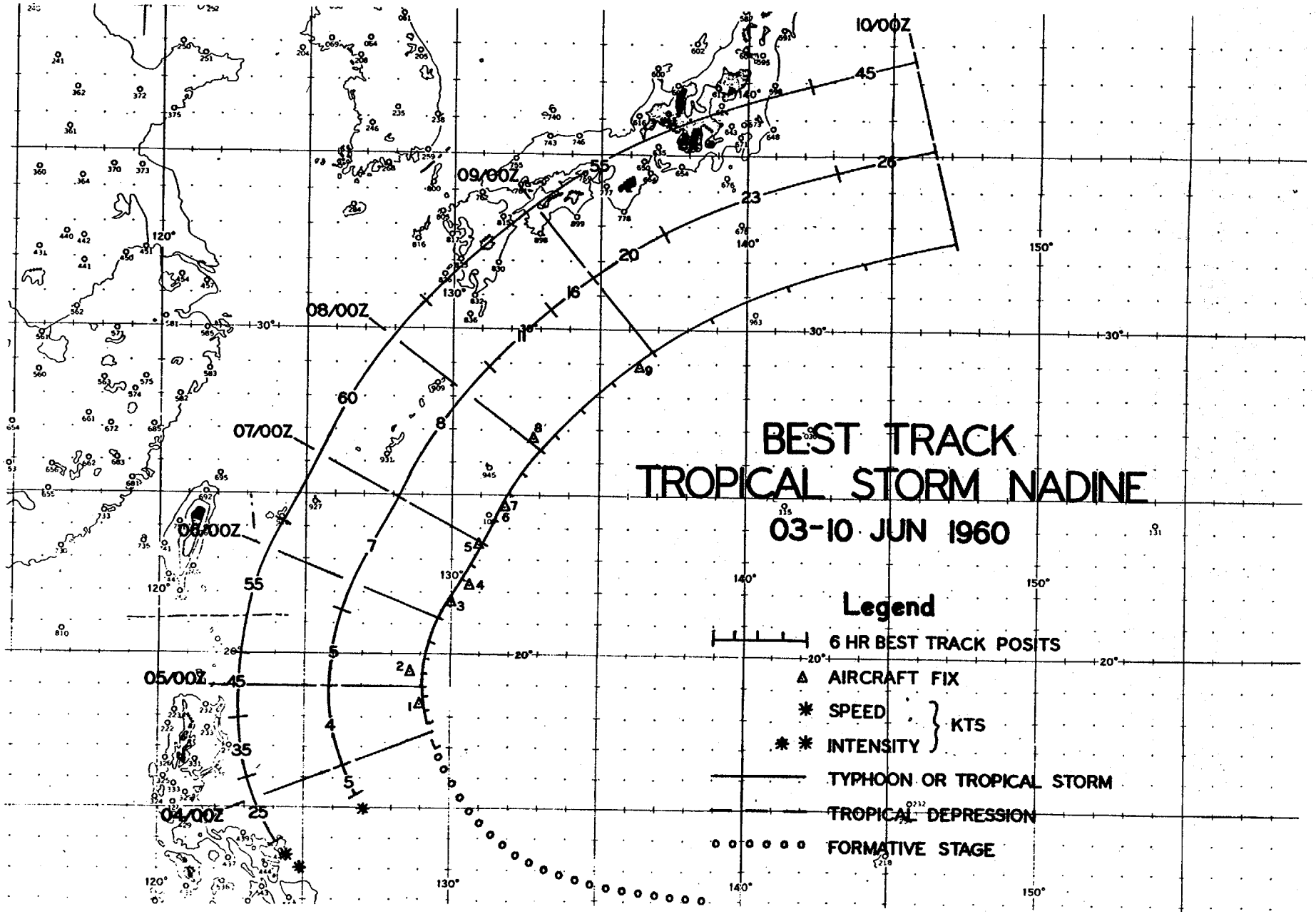
D. TROPICAL STORM NADINE (031800Z-100000Z JUNE 1960)

On 2 June at 1800Z a definite tropical cyclonic circulation was evident on the surface chart in the vicinity of 15N 131E. This low remained quasi-stationary for the next 18 hours while successive ship weather reports indicated a gradual decrease in pressure. At 031800Z the first warning was issued on T.D. 5, which later became T.S. NADINE.

For the first 30 hours NADINE moved N at an average speed of 5 kts. By 040600Z the central pressure of the depression appeared to be 1000 mb; one ship reported 25 kt surface winds, and two other ships reported 20 kts. The depression was then 400 mi E of northern Luzon, moving toward Okinawa. NADINE appeared to be intensifying at this time, although the first tropical storm warning was not issued until 050600Z. At 050000Z a ship very close to the center of the storm had a pressure of 992.3 mb. The central pressure was probably 990 mb, and NADINE was undoubtedly of tropical storm intensity at this time. The 050430Z fix indicated the maximum surface winds to be 55 kts, and the 050606Z fix indicated maximum winds of 45 kts. A ship on the 050600Z chart reported 45 kt surface winds as did another ship at 060000Z. After 051200Z the storm appeared to be moving slightly E of due N. A P2V (Neptune) reconnaissance aircraft reported maximum surface winds of 63 kts and 76 kts at 060220Z and 060310Z respectively. This plane also reported heavy weather in the NE quadrant of the storm. These two fixes definitely indicated that NADINE was moving NE at 060600Z and not towards Okinawa. The three fixes that were made on 7 June reported winds of 60, 60 and 65 kts, respectively. These fixes further confirmed that the storm was moving NE, and it may well have been of typhoon intensity at that time. As NADINE approached 30N, it began to accelerate. By 091200Z the storm showed signs of weakening and of becoming extratropical. The final warning was issued at 100000Z.

NADINE's existence aloft was first indicated by a cyclonic circulation at the 700 mb level between Koror and Guam at 010000Z. Successive maps indicated that the system was becoming more intense as the 700 mb heights decreased. At the 500 mb level the heights were below normal at 011200Z but it was not until 050000Z that it could be definitely established that NADINE was closed through the 500 mb level. NADINE followed the 300 mb flow as it moved around the western side of a high. By 100000Z when the final warning was issued NADINE's height extended to less than 10,000 ft.

A total of 26 warnings were issued covering a period of 6 days 6 hours. During this period, NADINE traveled 1450 mi at an average speed of 10 kts or 232 mi per day; its slowest speed was 4 kts on 4 June and its maximum speed was 26 kts on 9 June.


10/00Z
09/00Z
08/00Z
07/00Z
06/00Z
05/00Z
04/00Z
BEST TRACK
TROPICAL STORM NADINE
03-10 JUN 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE

RECONNAISSANCE AIRCRAFT FIXES - TROPICAL STORM NADINE

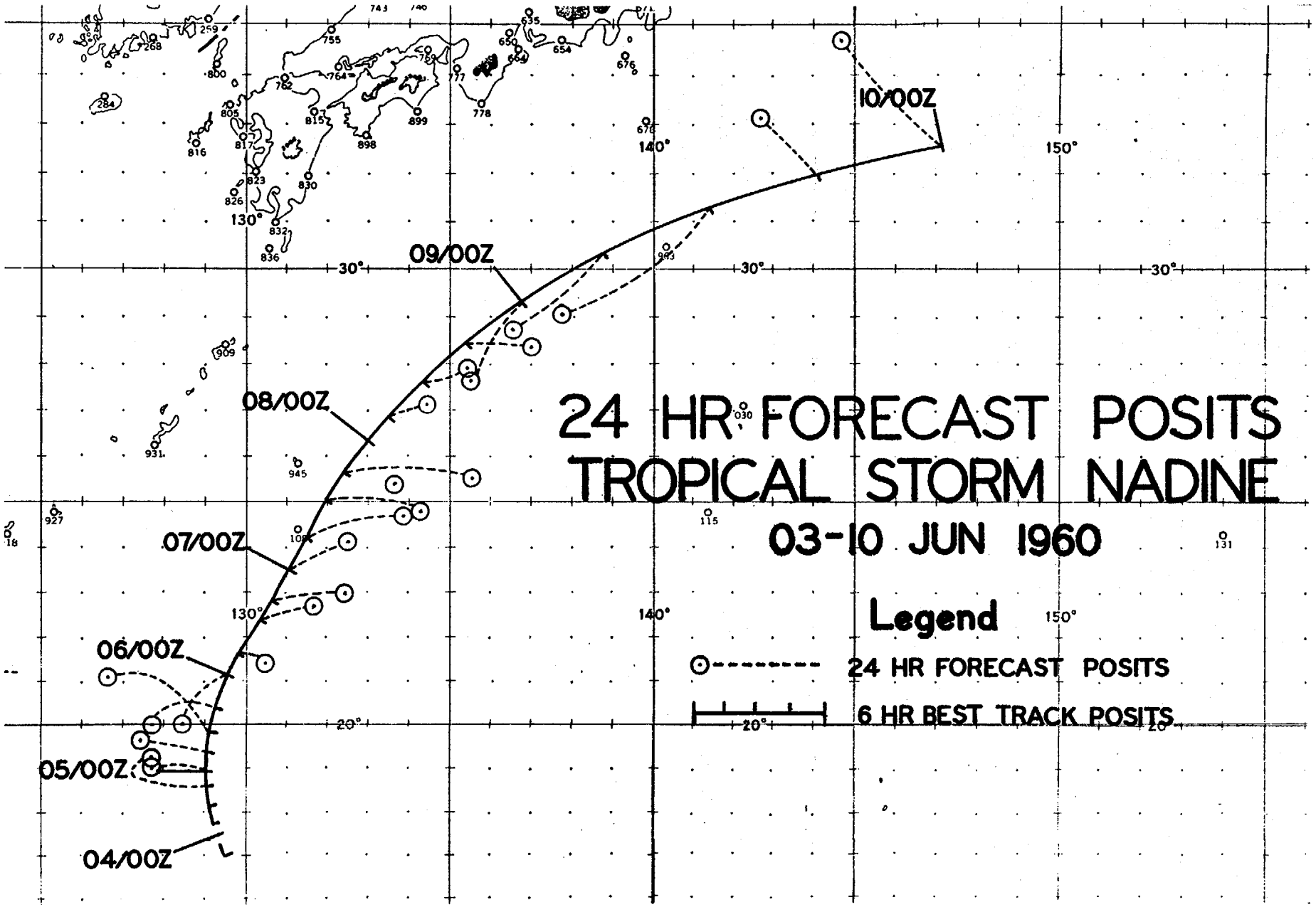
FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	050430Z	18.4N	129.1E	VW1-R---	- -	- -	- -	- -	- - -	WEAK CIRC BANDS, OPEN NW
2	050606Z	19.4N	128.7E	USN-P---	989	45	- -	- -	- - -	DIA 18 MI FAIRLY WELL DEFINED
3	060220Z	21.7N	130.0E	USN-P---	1000	63	- -	- -	- - -	CIRC DIA 140 MI
4	060310Z	22.1N	130.6E	USN-P---	1000	76	- -	- -	- - -	- - - - - - - - - - - - - - -
5	070045Z	23.5N	131.0E	USN-P-10	967	60	- -	- -	- - -	DIA 60 MI WALL CLDS EAST SEMI-CIR
6	070915Z	24.7N	131.8E	VW1-P-05	- -	60	- -	*20	- - -	- - - - - - - - - - - - - - -
7	071000Z	24.7N	131.8E	USN-P-10	996	65	- -	- -	- - -	- - - - - - - - - - - - - - -
8	080459Z	26.7N	132.8E	USN-R-20	- -	- -	- -	- -	- - -	- - - - - - - - - - - - - - -
9	082118Z	28.9N	136.3E	56-P-03	994	40	- -	34	21/20	CIRC

* MAX 850 MB WND

TROPICAL STORM NADINE 03-10 JUNE 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
031800Z	17.0N	129.6E	- - - -	- - - -
040000Z	17.5N	129.4E	- - - -	- - - -
040600Z	17.8N	129.3E	- - - -	- - - -
041200Z	18.2N	129.2E	- - - -	- - - -
041800Z	18.6N	129.1E	- - - -	- - - -
050000Z	19.0N	129.0E	- - - -	- - - -
050600Z	19.4N	129.0E	- - - -	- - - -
051200Z	19.9N	129.1E	- - - -	- - - -
051800Z	20.4N	129.3E	- - - -	- - - -
060000Z	21.1N	129.6E	- - - -	- - - -
060600Z	21.7N	129.9E	112-78	- - - -
061200Z	22.3N	130.4E	072-75	- - - -
061800Z	22.9N	130.7E	087-88	- - - -
070000Z	23.5N	131.1E	063-78	- - - -
070600Z	24.2N	131.5E	075-134	105-223
071200Z	25.0N	132.0E	095-123	087-256
071800Z	25.6N	132.5E	095-56	095-246
080000Z	26.3N	133.0E	145-71	075-195
080600Z	26.9N	133.5E	072-41	074-275
081200Z	27.7N	134.4E	076-58	087-210
081800Z	28.4N	135.4E	090-84	094-260
090000Z	29.3N	136.9E	219-130	134-153
090600Z	30.3N	138.9E	236-154	114-60
091200Z	31.2N	141.3E	237-223	183-48
091800Z	31.9N	144.1E	320-97	250-39
100000Z	32.6N	147.1E	320-178	243-390

AVERAGE 24 HOUR ERROR 104 MI
AVERAGE 48 HOUR ERROR 196 MI


24 HR FORECAST POSITS
TROPICAL STORM NADINE
03-10 JUN 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
10/00Z
09/00Z
08/00Z
07/00Z
06/00Z
05/00Z
04/00Z
L
140°
150°
130°
30°
20°

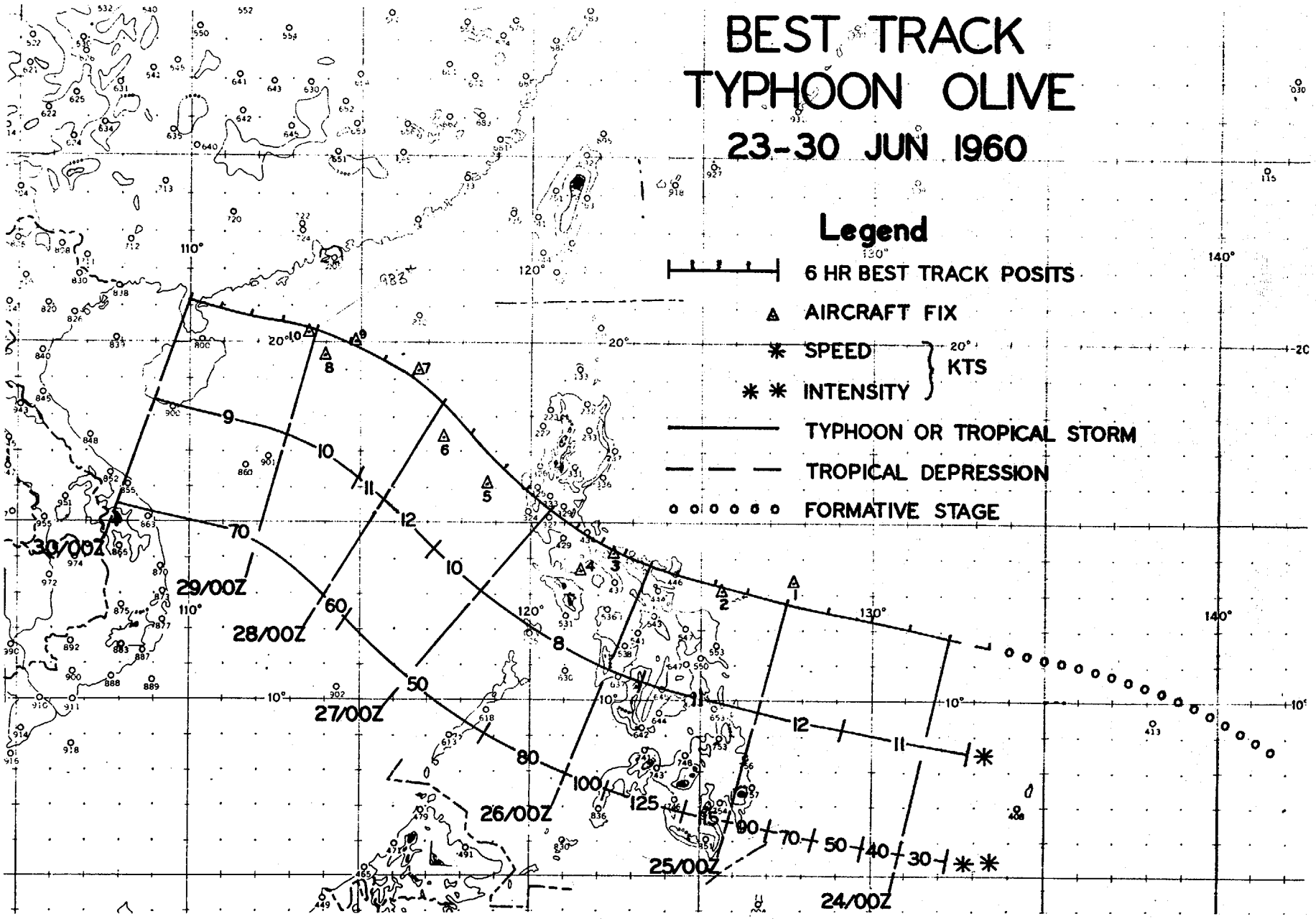
E. TYPHOON OLIVE (231800Z-300000Z JUNE 1960)

A weak circulation that was later to be named OLIVE appeared on 16 June between Woleai Atoll and Yap. It moved slowly W to the vicinity of Yap, then seemed to stagnate in that area from 18 to 21 June; again commencing a slow but steady movement WNW toward Manila, and intensifying enroute. At 231800Z the first warning was issued on T.D. OLIVE with surface winds of 30 kts. OLIVE reached storm intensity by 240000Z and typhoon intensity by 241200Z. Surface winds increased to 125 kts by 250600Z, but the typhoon rapidly weakened at the surface and later at upper levels as it passed inland over the Republic of the Philippines. It passed only 25 mi NE of Manila at 261800Z. Upon return to water surface, it intensified again into a typhoon, only to weaken as it moved inland near Fort Bayard, 228 mi WSW of Hong Kong at 292100Z.

OLIVE developed and intensified in a well developed band of surface easterlies SW of a large Pacific high centered near 32N 168E, which was extensively elongated E-W. This belt of easterlies extended through 30 to 35 degrees of latitude. In relation to the 40,000 ft streamline chart, OLIVE appeared to have originated beneath the SW end of the mid-Pacific trough, and then to have moved from beneath this trough into an area of divergence. The Clark AB upper winds indicate that OLIVE extended through the 40,000 ft level.

As OLIVE approached the Philippines from the E, a low commenced forming to the leeward side of the Philippines in the South China Sea. This position was near 16N and 114E at 260000Z. This low intensified as OLIVE passed over the Philippines, and by the time that OLIVE was also in the South China Sea (271800Z), surface analysis indicated that the low had an intensity comparable to that of OLIVE. Reconnaissance into this low revealed that it lacked the structure or wind speeds associated with typhoons, and by 280600Z the low existed only as a trough associated with OLIVE.

In view of some of the other tracks of the season, the most unusual feature of OLIVE is its excellent conformity to climatology for storms commencing near Yap and Koror during the month of June. The speeds varied from 8 kts on 26 June to 13 kts on 27 June, and the average direction of movement was 295 degrees. OLIVE traveled 1500 mi from first to last warning at an average speed of 10 kts or 240 mi each day over a period of 6 days and 6 hours.


BEST TRACK
TYPHOON OLIVE
23-30 JUN 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
30/00Z
29/00Z
28/00Z
27/00Z
26/00Z
25/00Z
24/00Z
110°
120°
130°
140°
20°
10°

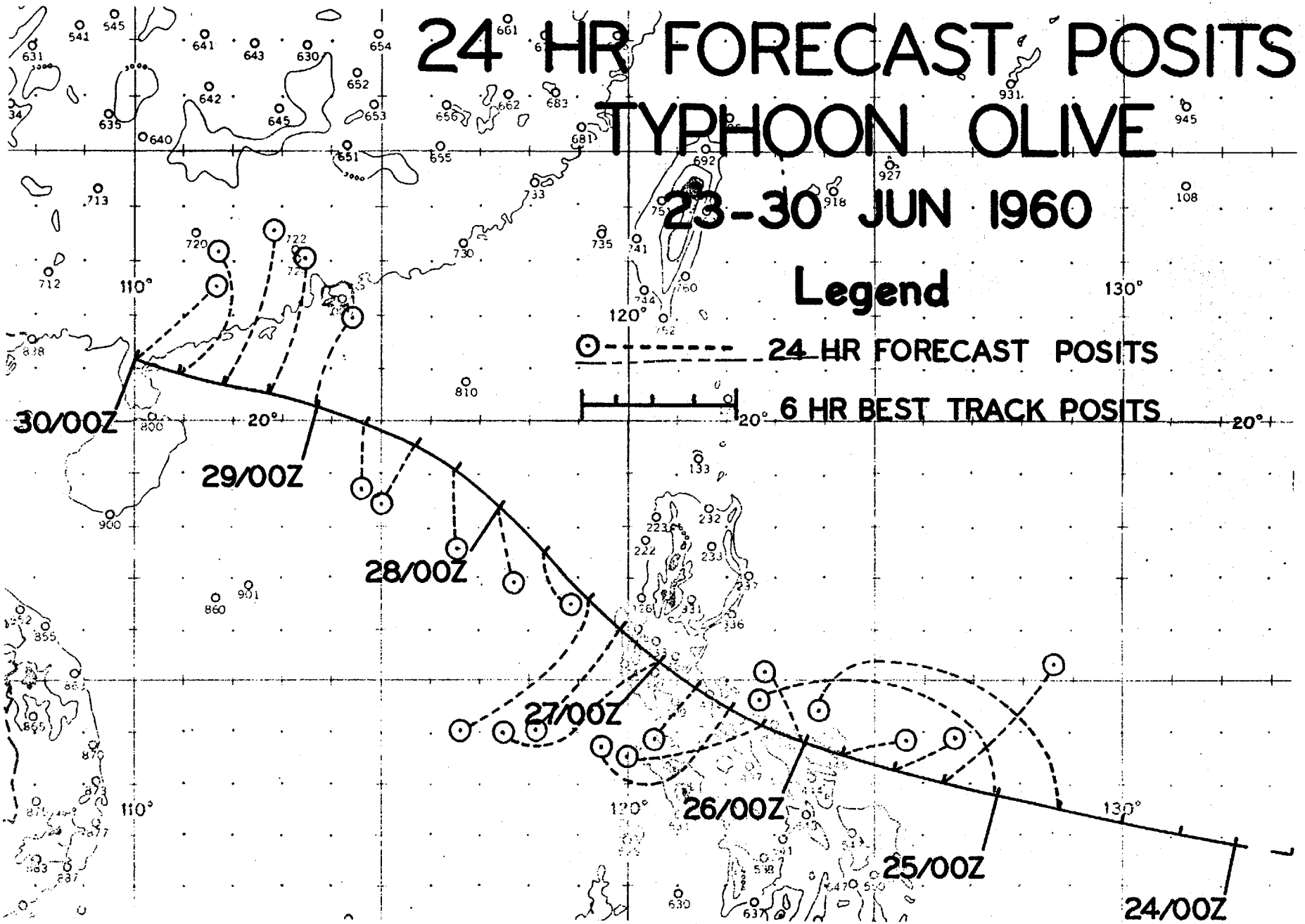
RECONNAISSANCE AIRCRAFT FIXES - TYPHOON OLIVE

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	250015Z	13.3N	127.8E	56-P-10	950	100	8800	110	16/--	DIA 05 MI WALL CLDS ALL QUADS
2	250830Z	13.1N	125.6E	USN-R---	- -	- -	- - -	- -	- - -	CIRC DIA 20 MI
3	252338Z	14.2N	122.4E	315-P-18	- -	- -	- - -	110	12/--	CIRC DIA 25 MI OPEN SE
4	261057Z	13.7N	121.3E	315-P-20	- -	80	- - -	100	07/--	NO VISIBLE EYE
5	271247Z	16.1N	118.8E	315-P-05	- -	30	10090	40	11/--	CIRC DIA 35 MI OPEN NE
6	280000Z	17.3N	117.3E	56-P-05	1000	- -	10040	35	09/09	ELLIP 20X12 MI
7	280500Z	19.2N	116.8E	56-P-08	989	60	9840	45	16/12	OPEN N & NE
8	282000Z	19.7N	114.0E	USN-R---	- -	- -	- - -	- -	- - -	CIRC DIA 20 MI OPEN E
9	282224Z	20.0N	114.9E	315-P-05	- -	75	- - -	60	- - -	CIRC DIA 35 MI OPEN W
10	290400Z	20.2N	113.5E	56-P-12	976	50	9640	50	19/14	OPEN N THRU SE

TYPHOON OLIVE 23-30 JUNE 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
231800Z	11.5N	133.3E	- - - -		- - - -	
240000Z	11.8N	132.2E	- - - -		- - - -	
240600Z	12.0N	131.1E	- - - -		- - - -	
241200Z	12.3N	130.0E	- - - -		- - - -	
241800Z	12.5N	128.8E	- - - -		- - - -	
250000Z	12.7N	127.6E	- - - -		- - - -	
250600Z	13.0N	126.4E	310	206	- - - -	
251200Z	13.3N	125.3E	062	86	- - - -	
251800Z	13.5N	124.3E	045	108	- - - -	
260000Z	13.7N	123.5E	335	88	- - - -	
260600Z	14.1N	122.8E	260	163	308	258
261200Z	14.4N	122.1E	258	165	032	65
261800Z	14.8N	121.4E	223	75	013	83
270000Z	15.3N	120.7E	248	198	295	179
270600Z	15.8N	119.9E	226	150	242	421
271200Z	16.5N	119.1E	224	203	233	342
271800Z	17.4N	118.2E	142	77	210	285
280000Z	18.3N	117.4E	163	83	236	430
280600Z	19.0N	116.5E	177	88	212	348
281200Z	19.5N	115.6E	208	75	215	403
281800Z	19.9N	114.7E	193	73	158	167
290000Z	20.2N	113.7E	021	108	153	102
290600Z	20.4N	112.7E	013	168	168	58
291200Z	20.7N	111.8E	019	180	194	31
291800Z	20.9N	110.9E	020	138	284	42
300000Z	21.2N	110.0E	049	116	008	275

AVERAGE 24 HOUR ERROR 127 MI
AVERAGE 48 HOUR ERROR 218 MI


24 HR FORECAST POSITS
TYPHOON OLIVE
23-30 JUN 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
30/00Z
29/00Z
28/00Z
27/00Z
26/00Z
25/00Z
24/00Z
110°
120°
130°
20°

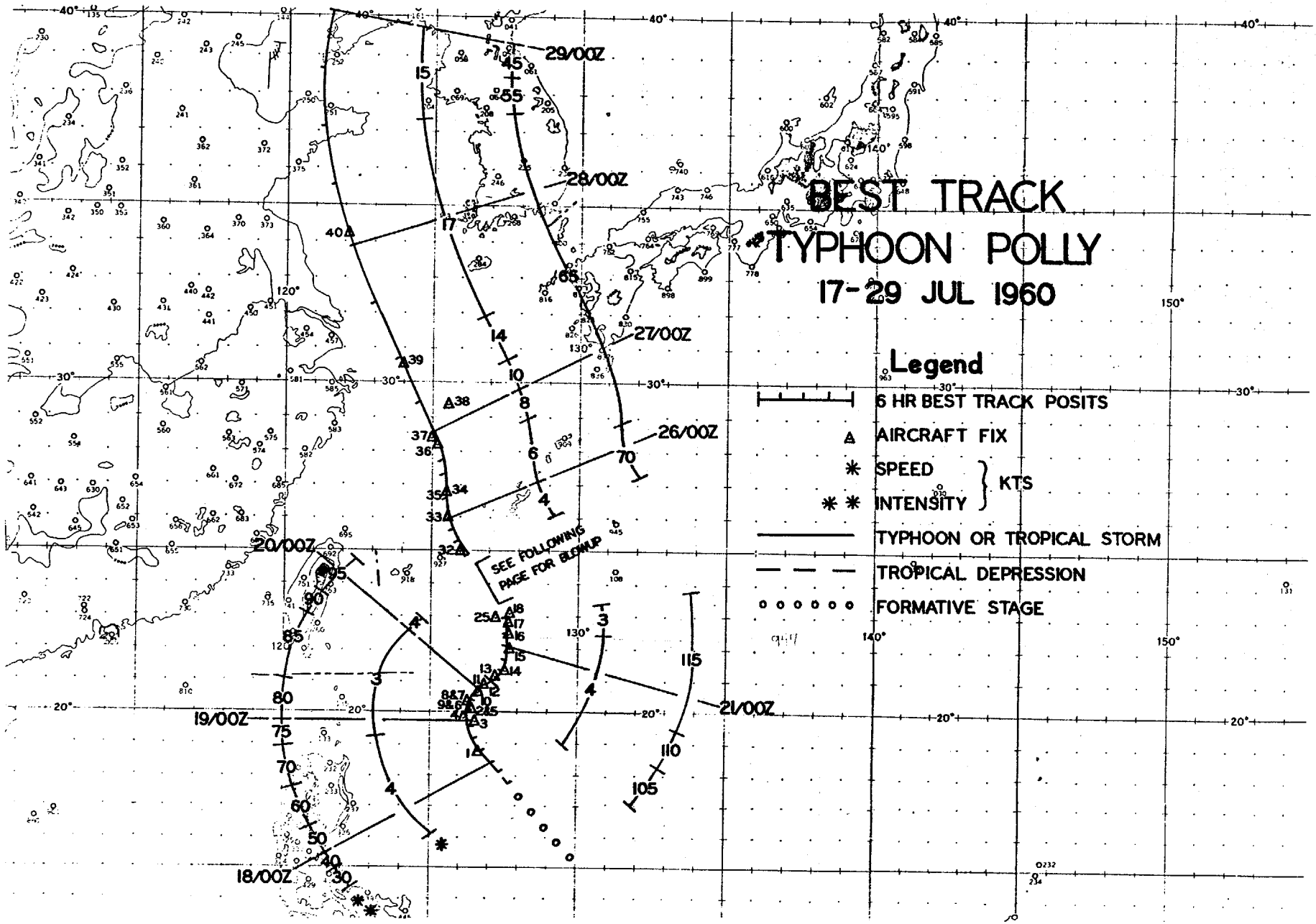
F. TYPHOON POLLY (171200Z-290000Z JULY 1960)

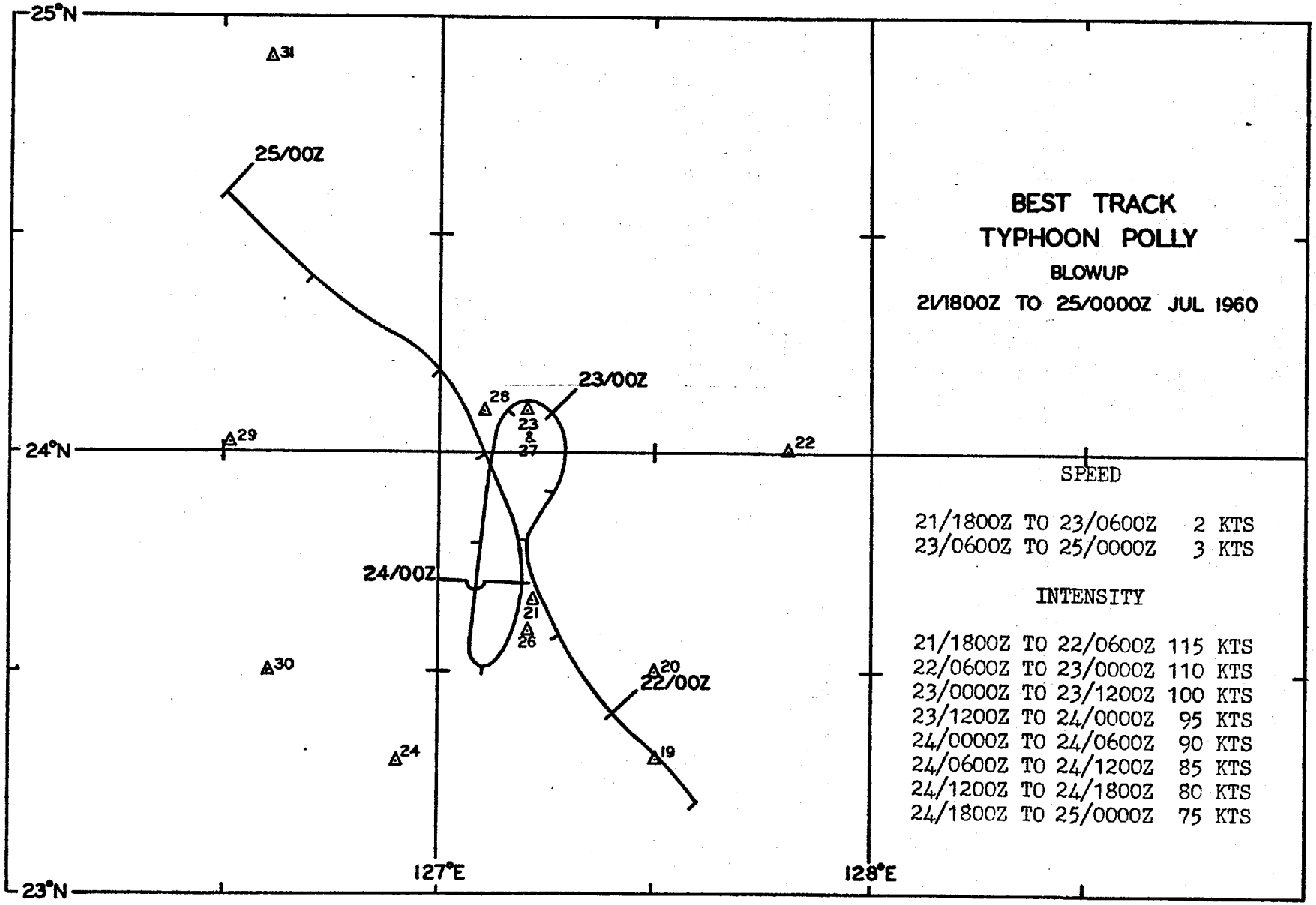
It is difficult to accurately determine the origin of POLLY; however, the depression that ultimately became POLLY appeared to have been quasi-stationary in the Yap-Koror area until 14 July, and then it moved NNW. This same depression appears to have passed several hundred mi S of Guam on 3 July. A warning was issued on this low (T.D. 7) at 171200Z, indicating maximum surface winds of 25 kts. Post-analysis indicates that POLLY became a storm at 171800Z and a typhoon at 181200Z with maximum winds of 70 kts near the center. The track of this typhoon until 211800Z was that of an inverted "S" with an average speed of 4 kts. POLLY then moved at an average speed of 2 kts until it reached a point 130 mi S of Naha, Okinawa at 230000Z. During this time POLLY continued to intensify until the surface winds reached 115 kts. The typhoon then became quasi-stationary until 241200Z, and actually completed a counterclockwise track through 360 degrees with an average movement of 2 kts between 230000Z and 240600Z. During this circuit the surface winds slowly decreased to 75 kts. The typhoon was 115 mi W of Naha, Okinawa at 260200Z becoming less intense and accelerating as it moved up the Yellow Sea toward Port Arthur. POLLY was moving at 17 kts by 271200Z and was downgraded to a storm at 281200Z when it was 270 mi W of Seoul, Korea.

When POLLY became a tropical storm the 180000Z surface chart indicated that easterlies extended from 30N to 10S latitude, with only a few troughs or vortices imbedded therein near the equator. This placed POLLY at the W or the downwind end of the easterlies. There was a large thermal low of 992 mb centered near 37N 103E on the Asiatic mainland. Such a synoptic pattern would suggest that the airflow over the W Pacific would be E-W to near the Asiatic mainland and the Philippines; then flow N or NNE along the E coast of the Asiatic mainland. This indicated a general track to the north for Typhoon POLLY to near 30-35N, and then a recurvature to the NE.

The average track of POLLY from first to last warning was 344 degrees. POLLY traveled 1550 mi from first to last warning over a period of 11 and one half days, at an average speed of 6 kts or 135 mi per day. The minimum speed was 2 kts on 22-23 July, and the maximum speed was 17 kts on 27-28 July.

The fact that POLLY "looped" is the only unusual feature associated with this typhoon. The eye diameter varied from 10 to 60 mi, and was reported most frequently as 25 mi in diameter.


BEST TRACK
TYPHOON POLLY
17-29 JUL 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
SEE FOLLOWING PAGE FOR BLOWUP
29/00Z
28/00Z
27/00Z
26/00Z
21/00Z
20/00Z
19/00Z
18/00Z


25°N
24°N
23°N
127°E
128°E
Δ31
Δ29
Δ28
Δ22
Δ30
Δ24
Δ20
Δ19
25/00Z
23/00Z
24/00Z
22/00Z
23 & 27
21 & 26
BEST TRACK
TYPHOON POLLY
BLOWUP
21/1800Z TO 25/0000Z JUL 1960
SPEED
21/1800Z TO 23/0600Z 2 KTS
23/0600Z TO 25/0000Z 3 KTS
INTENSITY
21/1800Z TO 22/0600Z 115 KTS
22/0600Z TO 23/0000Z 110 KTS
23/0000Z TO 23/1200Z 100 KTS
23/1200Z TO 24/0000Z 95 KTS
24/0000Z TO 24/0600Z 90 KTS
24/0600Z TO 24/1200Z 85 KTS
24/1200Z TO 24/1800Z 80 KTS
24/1800Z TO 25/0000Z 75 KTS

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON POLLY

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	180725Z	18.8N	126.8E	56-P-5	990	75	10260	55	13/8	ELLIP 15X10 MI
2	190112Z	20.1N	126.4E	315-P-20	- -	50	- -	- -	-/-	22 MI WIDE WALL CLD NW
3	190300Z	19.8N	126.5E	315-P-5	- -	85	9320	- -	17/-	DIFFUSE 20 MI WIDE
4	190400Z	19.9N	126.2E	VW1-R-5	- -	- -	- -	- -	-/-	CIRC DIA 25 MI
5	190700Z	20.1N	126.4E	315-P-5	- -	90	9280	- -	18/-	DIFFUSE 20 MI WIDE
6	190800Z	20.2N	126.4E	56-P-5	- -	- -	- -	- -	16/10	DIFFUSE OPEN S & W
7	190911Z	20.2N	126.3E	56-P-5	- -	70	9410	- -	17/11	DIFFUSE ELLIP
8	191430Z	20.2N	126.1E	VW1-R-10	- -	- -	- -	- -	- - -	CIRC DIA 35 MI
9	191500Z	20.3N	126.3E	VW1-R-05	- -	- -	- -	- -	- - -	- - - - - - - - - - - - - -
10	192245Z	20.7N	126.7E	56-P-04	962	90	9590	65	18/13	CIRC DIA 25 MI
11	200330Z	20.9N	126.9E	315-P-05	- -	100	- -	- -	- - -	CIRC DIA 30 MI
12	200400Z	20.9N	126.9E	56-P-1/4	957	95	9470	- -	15/13	CIRC DIA 10 MI
13	200930Z	21.2N	127.2E	56-P-03	955	90	8830	80	17/12	CIRC DIA 25 MI
14	201522Z	21.3N	127.5E	VW1-R-03	- -	- -	- -	- -	- - -	CIRC DIA 26 MI
15	202245Z	22.0N	127.8E	56-P-04	954	125	9120	115	16/15	CIRC DIA 25 MI
16	210330Z	22.4N	127.8E	315-P-05	- -	125	8630	60	18/--	CIRC DIA 20 MI
17	210930Z	22.8N	127.7E	56-P-02	952	90	8710	84	17/15	CIRC DIA 20 MI
18	211511Z	23.1N	127.8E	VW1-R-05	- -	- -	- -	- -	- - -	ELONGATED 35 MI DIA
19	212141Z	23.3N	127.5E	56-P-05	953	90	8860	85	14/12	CIRC DIA 40 MI
20	220400Z	23.5N	127.5E	315-P-05	- -	110	8830	- -	18/--	CIRC DIA 30 MI
21	220926Z	23.7N	127.2E	56-P-05	950	75	9370	70	13/11	CIRC DIA 18 MI OPEN SE
22	221000Z	24.0N	127.8E	56-P-05	952	65	8980	80	14/14	DIFFUSE

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON POLLY (CONT'D)

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
23	230600Z	24.1N	127.2E	315-P---	- -	- -	9430	- -	17/--	- - - - - - - - - - - - - -
24	230904Z	23.2N	126.9E	56-P-05	966	60	9130	90	15/13	CIRC DIA 10 MI DIFFUSE
25	231456Z	23.0N	127.1E	VW1-R-05	- -	- -	- -	- -	- - -	CIRC DIA 40 MI
26	232121Z	23.6N	127.2E	56-P-07	970	- -	9320	50	18/18	DIFFUSE
27	240415Z	24.1N	127.2E	315-P-05	- -	- -	9550	- -	14/--	CIRC DIA 60 MI OPEN NW
28	240921Z	24.1N	127.1E	56-P-05	979	- -	9440	60	13/12	DIFFUSE
29	241558Z	24.0N	126.5E	VW1-R-15	- -	- -	- -	- -	- - -	EYE NOT DEFINED
30	242100Z	24.5N	126.6E	56-P-03	984	- -	9680	63	12/07	DIFFUSE NO WALL CLDS
31	250330Z	24.9N	126.6E	315-P-05	- -	75	9580	- -	15/--	EYE NOT DEFINED
32	250931Z	25.0N	126.0E	56-P-02	- -	75	9550	60	13/13	NO VISIBLE EYE
33	260002Z	26.0N	125.6E	56-P-03	- -	65	- -	- -	- - -	50 MI DIA OPEN S
34	260455Z	26.7N	125.5E	315-----	- -	75	- -	- -	- - -	- - - - - - - - - - - - - -
35	260945Z	26.8N	126.5E	56-P-05	990	80	9740	65	13/13	CIRC DIA 20 MI
36	261525Z	28.1N	125.1E	VW1-R-20	- -	- -	- - -	- -	- - -	HVY SPIRAL BANDS
37	262200Z	28.2N	125.0E	56-P-10	992	65	9470	83	15/12	CIRC DIA 30 MI
38	270545Z	29.3N	125.4E	315-P---	- -	60	9690	- -	- - -	NO EYE FOUND
39	271132Z	30.6N	124.0E	56-R---	- -	- -	- -	- -	- - -	- - - - - - - - - - - - - -
40	280020Z	34.2N	122.1E	315-P-05	- -	45	9640	- -	14/--	CIRC DIA 18 MI DIFFUSE

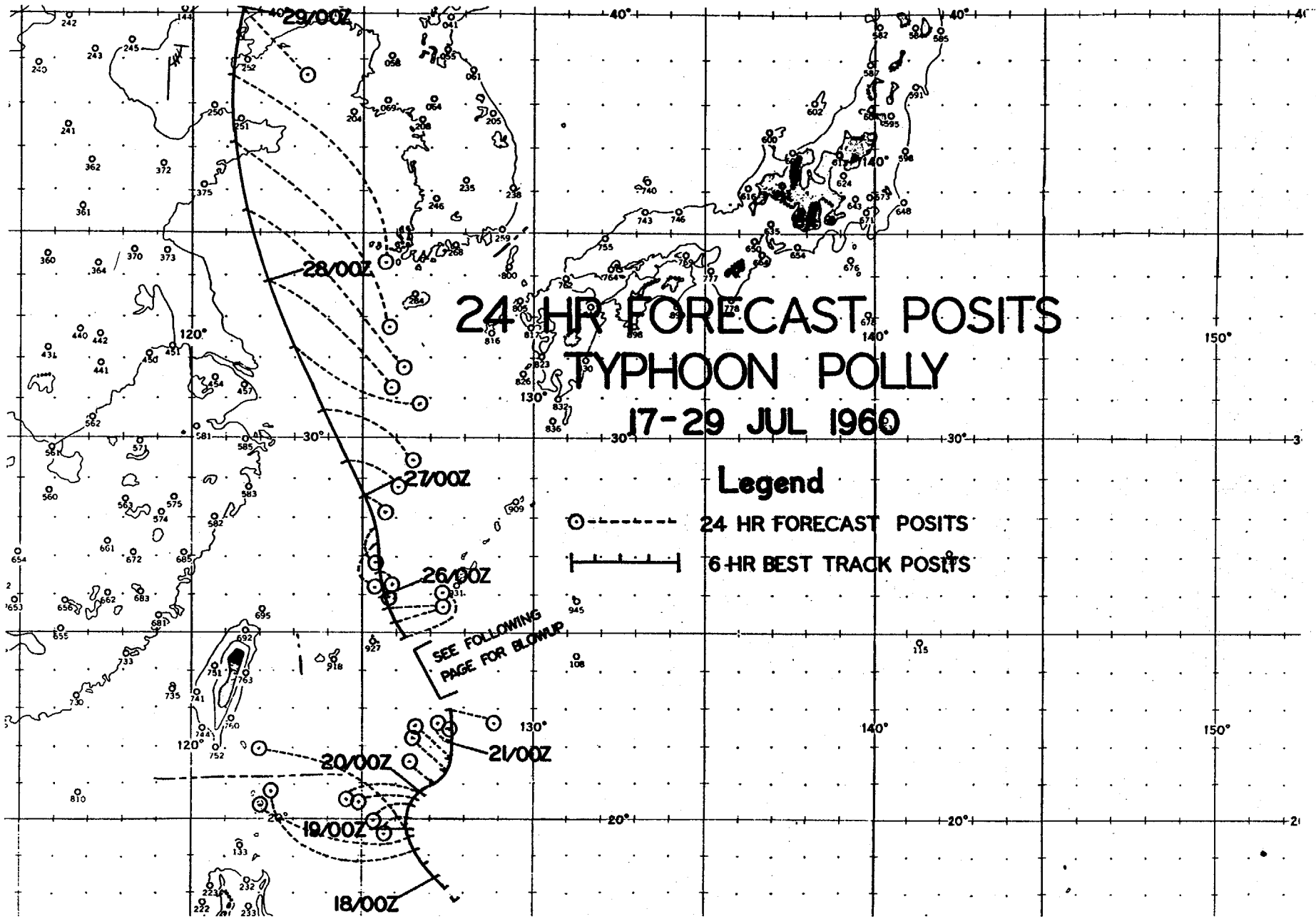
TYPHOON POLLY 17-29 JULY 1960
POSITION AND FORECAST VERIFICATION DATA

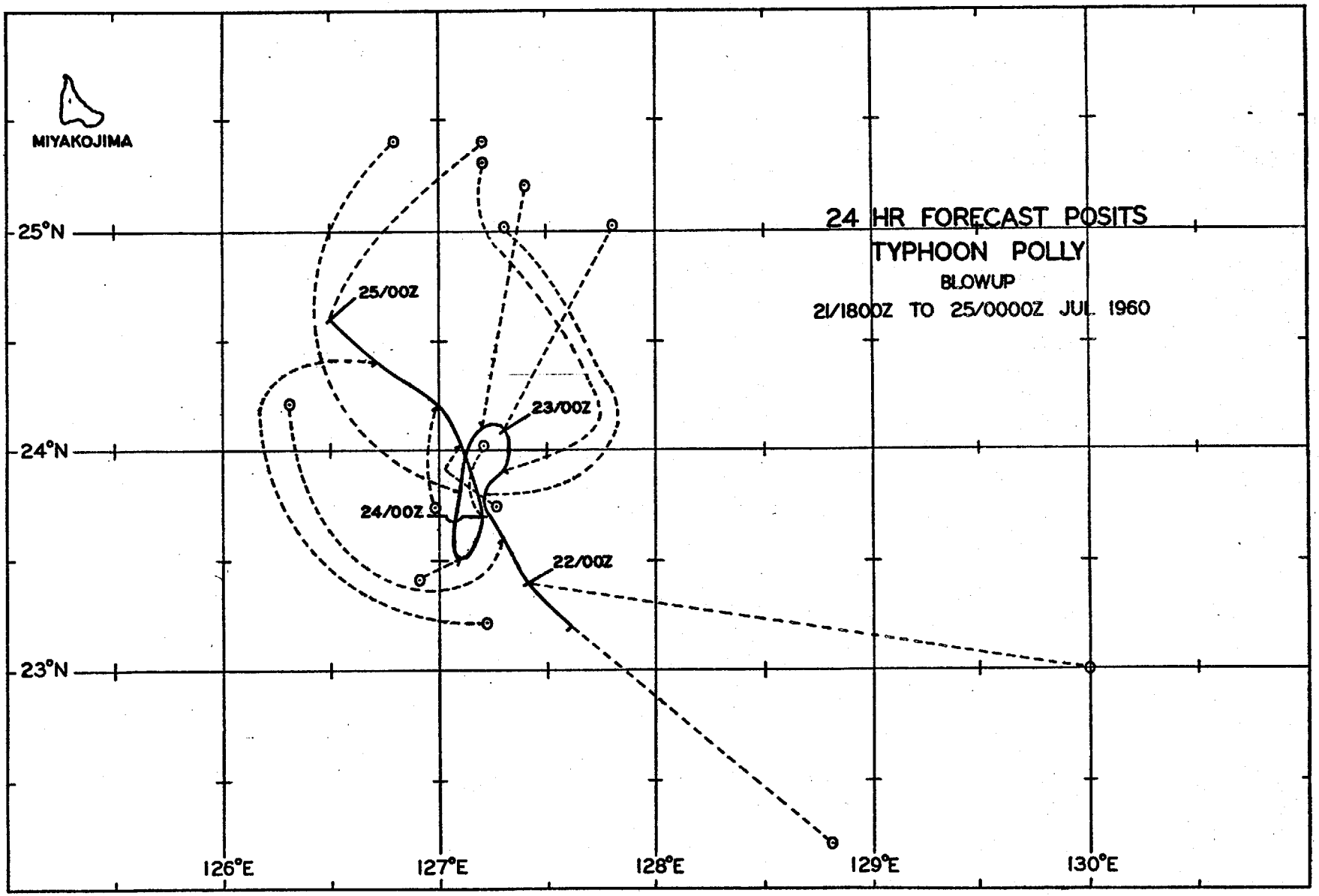
DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
171200Z	17.7N	127.6E	- - - -		- - - -	
171800Z	18.1N	127.4E	- - - -		- - - -	
180000Z	18.4N	127.1E	- - - -		- - - -	
180600Z	18.8N	126.9E	- - - -		- - - -	
181200Z	19.1N	126.6E	- - - -		- - - -	
181800Z	19.5N	126.5E	- - - -		- - - -	
190000Z	19.7N	126.4E	301	278	- - - -	
190600Z	20.0N	126.3E	244	46	- - - -	
191200Z	20.3N	126.4E	248	72	- - - -	
191800Z	20.6N	126.5E	261	93	- - - -	
200000Z	20.8N	126.7E	263	122	340	372
200600Z	21.0N	127.1E	003	165	259	170
201200Z	21.3N	127.3E	314	67	259	210
201800Z	21.7N	127.6E	305	75	264	224
210000Z	22.1N	127.8E	316	44	263	256
210600Z	22.5N	127.8E	228	20	338	85
211200Z	23.0N	127.7E	108	70	028	92
211800Z	23.2N	127.6E	129	96	044	118
220000Z	23.4N	127.4E	100	155	066	155
220600Z	23.6N	127.3E	302	70	084	194
221200Z	23.8N	127.2E	004	74	090	296
221800Z	23.9N	127.3E	358	83	097	255
230000Z	24.1N	127.3E	027	64	090	392
230600Z	24.1N	127.2E	010	67	336	132
231200Z	23.8N	127.1E	351	98	353	211
231800Z	23.5N	127.1E	259	14	352	242
240000Z	23.7N	127.2E	005	16	007	223
240600Z	24.0N	127.1E	162	17	001	217
241200Z	24.2N	127.0E	159	32	005	210
241800Z	24.4N	126.7E	160	77	172	61
250000Z	24.6N	126.5E	041	65	132	55
250600Z	24.9N	126.2E	039	86	143	88
251200Z	25.2N	125.9E	060	84	146	105
251800Z	25.6N	125.8E	089	78	150	165

TYPHOON POLLY 17-29 JULY 1960
POSITION AND FORECAST VERIFICATION DATA (CONT'D)

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
260000Z	26.0N	125.6E	141-24	053-103
260600Z	26.6N	125.5E	143-35	032-163
261200Z	27.2N	125.4E	168-52	078-106
261800Z	27.7N	125.2E	173-69	119-122
270000Z	28.5N	125.0E	119-48	165-100
270600Z	29.4N	124.5E	112-87	158-137
271200Z	30.7N	123.9E	120-156	162-209
271800Z	32.3N	123.1E	115-199	162-294
280000Z	33.9N	122.3E	132-240	118-305
280600Z	35.5N	121.6E	- - - -	- - - -
281200Z	37.1N	121.2E	- - - -	- - - -
281800Z	38.6N	121.1E	- - - -	- - - -
290000Z	40.1N	121.4E	- - - -	- - - -

AVERAGE 24 HOUR ERROR 85 MI
AVERAGE 48 HOUR ERROR 184MI


29/00Z
28/00Z
27/00Z
26/00Z
21/00Z
20/00Z
19/00Z
18/00Z
SEE FOLLOWING PAGE FOR BLOWUP
24 HR FORECAST POSITS
TYPHOON POLLY
17-29 JUL 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
120°
130°
140°
150°
40°
30°
20°


MIYAKOJIMA
24 HR FORECAST POSITS
TYPHOON POLLY
BLOWUP
21/1800Z TO 25/0000Z JUL 1960
25°N
24°N
23°N
126°E
127°E
128°E
129°E
130°E
25/00Z
24/00Z
23/00Z
22/00Z

G. TYPHOON SHIRLEY (291200Z JULY-060000Z AUGUST 1960)

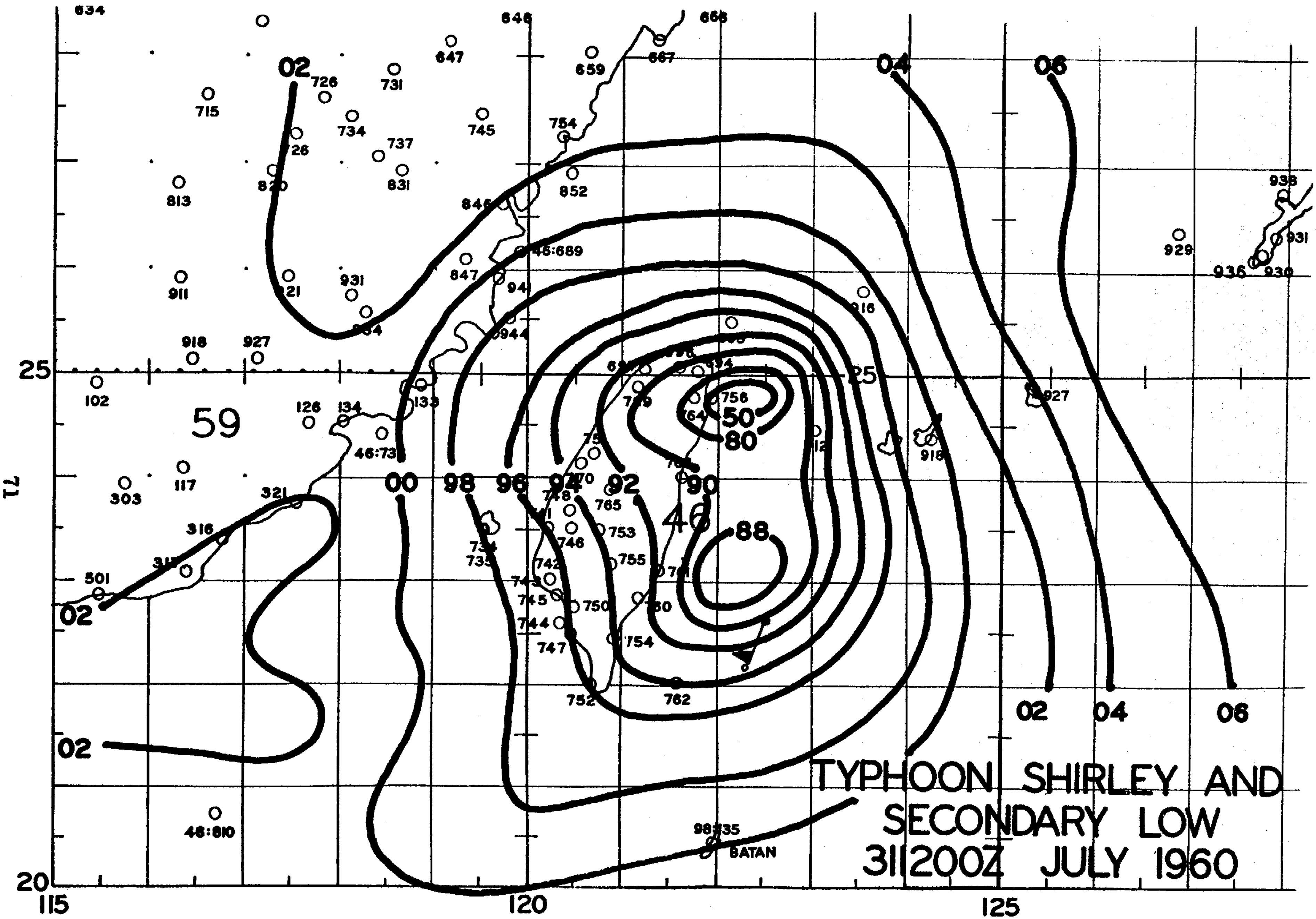
Typhoon SHIRLEY appeared to be waiting for POLLY to move off stage before beginning her performance. At 251200Z, when POLLY was about 1150 mi NW of Yap, a circulation rapidly developed near Yap and commenced a NW movement, essentially along a similar but more westerly track than POLLY had followed, traveling at 11 kts for the first 4 days. This circulation was lost for two days due to lack of data and was not detected again until 281200Z. At 290600Z the surface chart provided enough information to indicate that SHIRLEY had become a storm, although the intensity was unknown. The first warning was issued at 291200Z and the first typhoon warning was issued at 300600Z as SHIRLEY rapidly intensified and decelerated to a speed of 8 kts. By 301800Z, when the typhoon was 180 mi SE of the Taipei radio homing beacon, it had intensified to 135 kts. A trough was apparent at the S end of Taiwan on the 310600Z surface chart when SHIRLEY was 60 mi E of Taiwan and 85 mi SE of the Taipei homing beacon. As SHIRLEY approached Taipei, a low developed in the trough, intensified and moved NE from the S tip of Taiwan at 6 kts. Surface wind speeds were reported at 50 kts just SE of this low center. The secondary low dissipated rapidly after SHIRLEY passed over Taiwan. By 311800Z the typhoon was 16 mi W of the Taipei homing beacon, and the secondary low had virtually disappeared. The typhoon continued to weaken after departing Taiwan and was downgraded to a tropical storm at 011200Z, 12 mi inland of the Asiatic coastline. Warnings were discontinued at 021800Z and were commenced again at 041200Z when the storm was in the Yellow Sea. The last warning was issued at 060000Z when the storm was considered unlikely to create further damage.

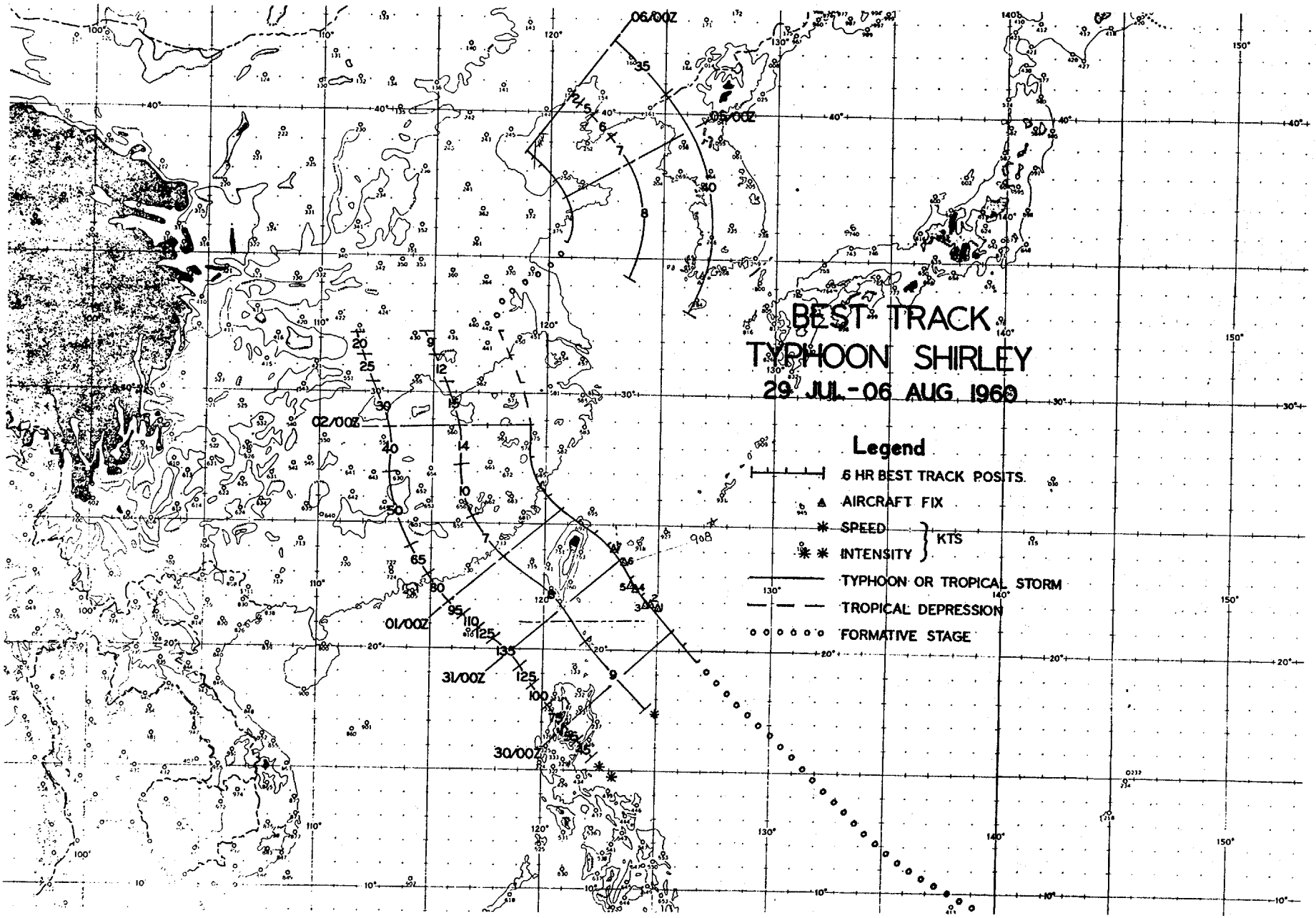
The eye of Typhoon SHIRLEY was well defined and small. The minimum reported diameter was 7 mi, and the maximum 12 mi, and the most frequently reported diameter was 9 mi. Synoptically the situation associated with SHIRLEY was similar to the one associated with POLLY.

Typhoon SHIRLEY traveled 1400 mi over a period of 7 and one half days at an average speed of 8 kts or 189 mi per day. The minimum rate of movement was 2 kts on 5 August, and the maximum rate of movement was 15 kts on 2 August when SHIRLEY was over the Asiatic mainland.

The unusual feature of this typhoon was the formation of the secondary low while in the vicinity of Taiwan. (See the 311200Z July sectional chart herein) This effect occurs because of the modification of the strong winds associated with typhoons by the high terrain of the

Central Mountain Range. An excellent discussion entitled "The Problem of Typhoon Forecasting Over Taiwan and Its Vicinity" was presented at the 1960 U.S. - Asian Military Weather Symposium, 9-12 February 1960, by Lt. Colonel Hsu Ying-Chin, Chief, Weather Central, Chinese Air Force, and is available in the official summary published by 1st Weather Wing, USAF.


TYPHOON SHIRLEY AND
SECONDARY LOW
311200Z JULY 1960
115
120
125
20
25
BATAN


BEST TRACK
TYPHOON SHIRLEY
29 JUL - 06 AUG 1960
Legend
6 HR BEST TRACK POSITS.
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
06/00Z
05/00Z
02/00Z
01/00Z
31/00Z
30/00Z

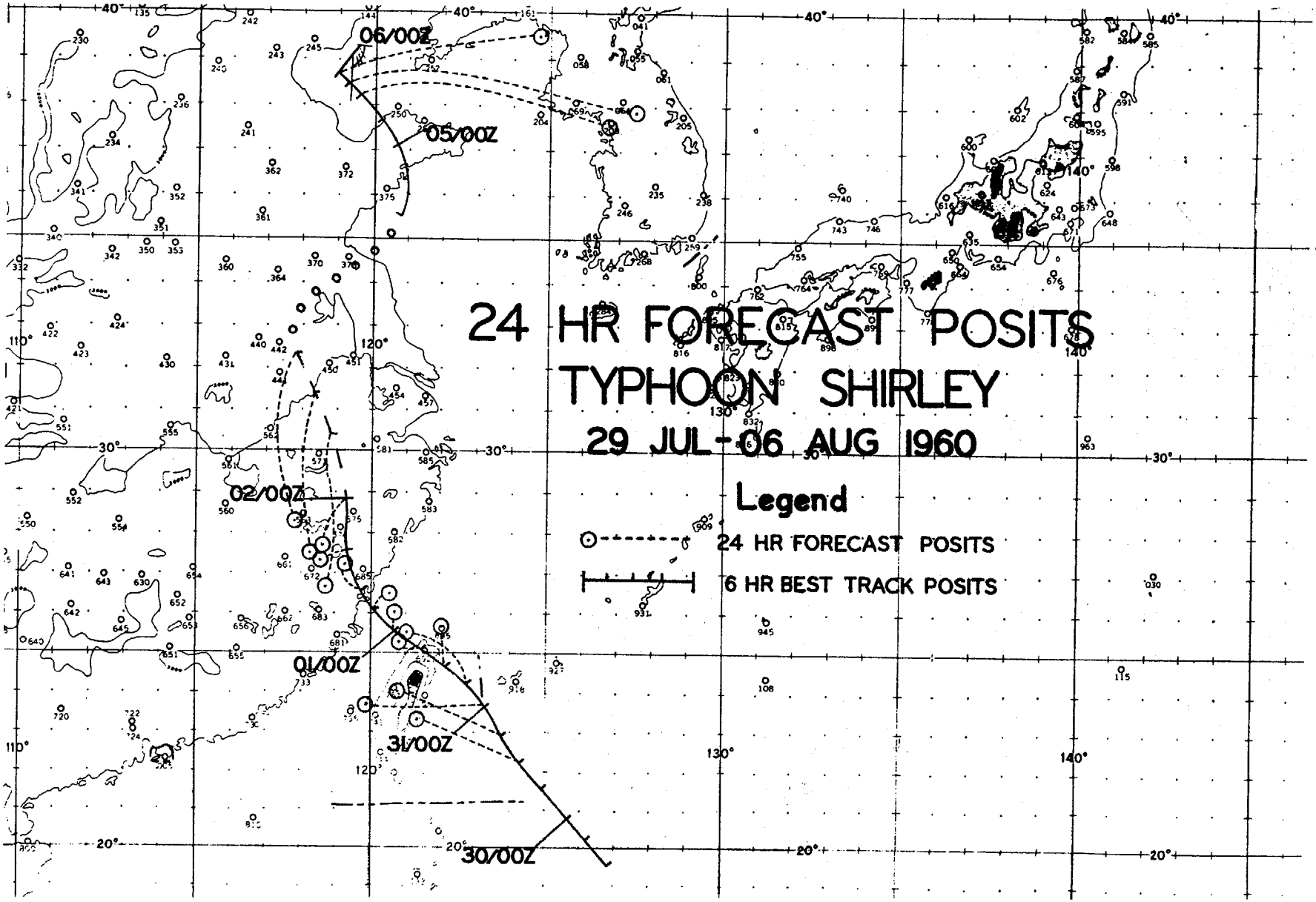
RECONNAISSANCE AIRCRAFT FIXES - TYPHOON SHIRLEY

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	300402Z	21.8N	125.0E	VW1-R-10	- -	- -	- -	- -	- - -	CIRC DIA 11 MI
2	300900Z	21.9N	124.8E	315-P-03	- -	85	7820	65	21/--	WELL DEFINED
3	301410Z	21.9N	124.7E	VW1-R-05	- -	- -	- -	- -	- - -	CIRC DIA 09MI WELL DEFINED
4	301500Z	22.5N	124.0E	VW1-R-10	- -	- -	- -	- -	- - -	CIRC DIA 09MI WELL DEFINED
5	301600Z	22.6N	123.9E	VW1-R-05	- -	- -	- -	- -	- - -	CIRC DIA 07MI WELL DEFINED
6	302323Z	23.5N	123.5E	315-P-05	- -	130	7510	100	20/--	CIRC DIA 10 MI
7	310250Z	24.1N	123.0E	315-P-10	- -	130	7560	105	20/--	CIRC DIA 12 MI OPEN S

TYPHOON SHIRLEY 29 JULY-06 AUGUST 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
291200Z	19.6N	126.9E	- - - -	- - - -
291800Z	20.2N	126.2E	- - - -	- - - -
300000Z	20.8N	125.6E	- - - -	- - - -
300600Z	21.6N	125.0E	- - - -	- - - -
301200Z	22.2N	124.3E	292-188	- - - -
301800Z	22.8N	123.8E	291-186	- - - -
310000Z	23.6N	123.4E	271-195	- - - -
310600Z	24.2N	122.8E	308-138	- - - -
311200Z	24.7N	122.2E	354-68	334-425
311800Z	25.1N	121.4E	315-36	325-300
010000Z	25.5N	120.7E	360-33	310-289
010600Z	26.0N	120.1E	037-28	332-315
011200Z	26.6N	119.7E	330-65	011-166
011800Z	27.6N	119.3E	268-60	350-65
020000Z	28.9N	119.3E	206-96	212-52
020600Z	30.4N	118.9E	356-78	197-82
021200Z	31.4N	118.2E	140-18	179-43
021800Z	32.3N	117.9E	180-248	213-116
021800Z TO 041200Z NO WARNINGS ISSUED				
041200Z	35.6N	120.9E	- - - -	- - - -
041800Z	36.3N	121.0E	- - - -	- - - -
050000Z	37.1N	120.7E	- - - -	- - - -
050600Z	37.7N	120.2E	- - - -	- - - -
051200Z	38.2N	119.7E	- - - -	- - - -
051800Z	38.5N	119.2E	- - - -	- - - -
060000Z	38.6N	119.0E	- - - -	- - - -

AVERAGE 24 HOUR ERROR 103 MI
AVERAGE 48 HOUR ERROR 185 MI


24 HR FORECAST POSITS
TYPHOON SHIRLEY
29 JUL - 06 AUG 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
06/00Z
05/00Z
02/00Z
01/00Z
31/00Z
30/00Z
40°
30°
20°
110°
120°
130°
140°

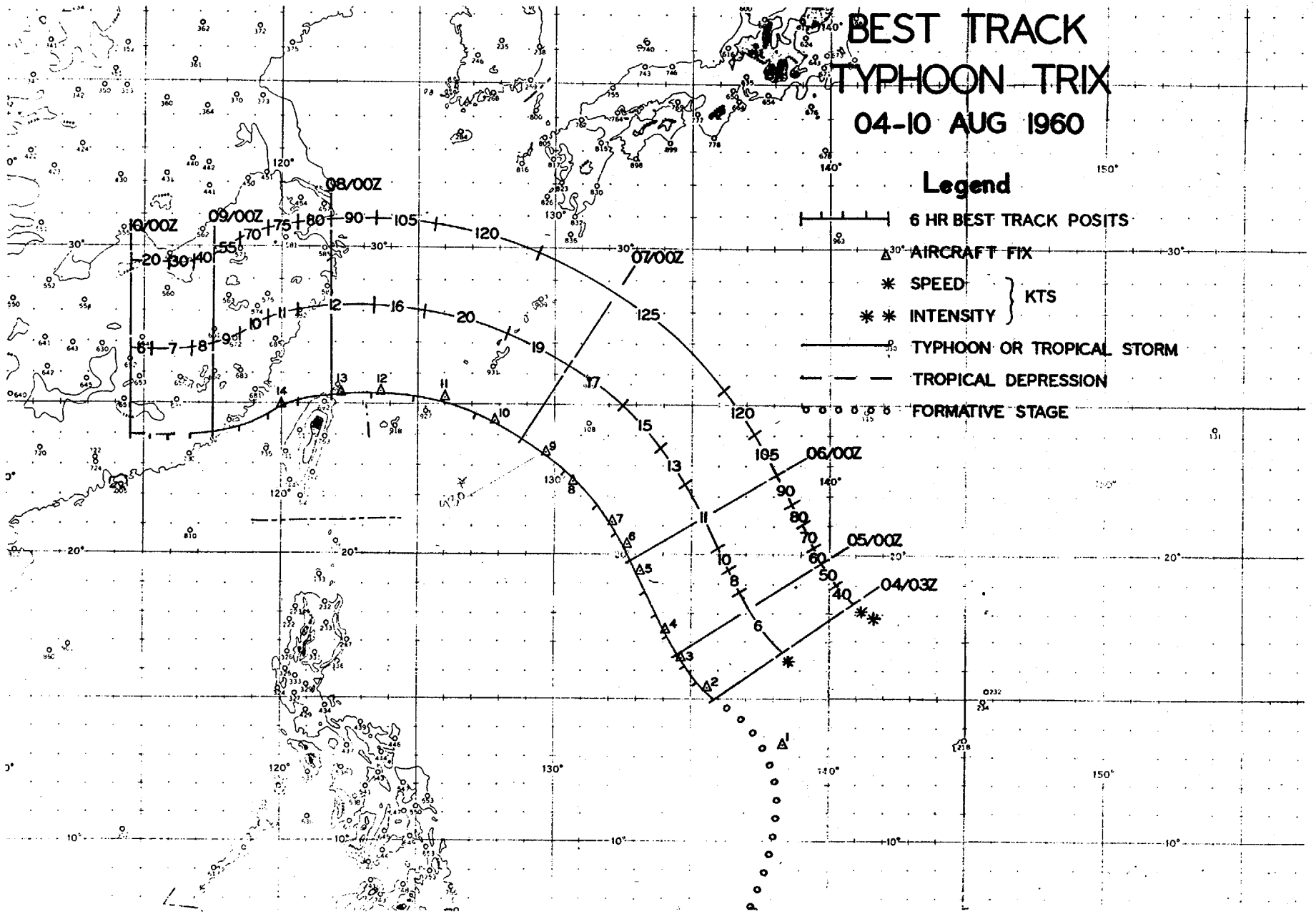
H. TYPHOON TRIX (040300Z-100000Z AUGUST 1960)

Typhoon TRIX was the third of a series of typhoons that developed in succession near the Yap-Koror area and intensified after departure from that area. At 300000Z a cyclonic vortex existed in the Yap-Koror area and appeared to have formed not more than 12 to 18 hours prior to that time. This low moved N and then NW toward Okinawa at 5 to 6 kts. A MATS transport aircraft observed the circulation as it flew the Manila-Guam flight track and reported the position to FWC/JTWC. The first warning was issued at 040300Z with 40 kt surface winds near the center and with intensification expected. The first typhoon warning was issued at 051800Z, although post analysis indicated typhoon winds at 050600Z. Surface winds about TRIX intensified to 125 kts by 061200Z and commenced weakening at 070600Z. The speed of movement increased from 6 kts at 040300Z to a maximum of 20 kts at 070600Z when Typhoon TRIX was 85 mi SSW of Naha, Okinawa. The typhoon turned W, passed over the N tip of Taiwan at 080200Z, and then moved toward the WSW. The last warning was issued at 100000Z when the last vestiges of TRIX was 105 mi N of Hong Kong.

As Typhoon TRIX approached Taiwan, a trough commenced developing at the S tip of the island at 071200Z. By 080000Z a closed circulation existed 150 mi S of the Typhoon just off the E coast of Taiwan. The surface winds appear to have reached a maximum speed of 40 kts about this secondary low associated with Typhoon SHIRLEY; this low persisted as a closed circulation until TRIX was near the coast line of the Asiatic mainland at approximately 081800Z.

The eye of TRIX was well defined throughout its life as a typhoon with a minimum reported eye diameter of 10 mi and a maximum diameter of 60 mi. The most frequently reported diameter was 10 mi, although the average diameter was probably 25 to 30 mi in relation to time.

Typhoon TRIX traveled 1500 mi in 5 days and 21 hours at an average speed of 11 kts or 254 mi each day. On 4 August the typhoon moved at a minimum speed of 6 kts, and on 7 August it moved at a maximum speed of 20 kts.


BEST TRACK
TYPHOON TRIX
04-10 AUG 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
10/00Z
09/00Z
08/00Z
07/00Z
06/00Z
05/00Z
04/03Z

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON TRIX

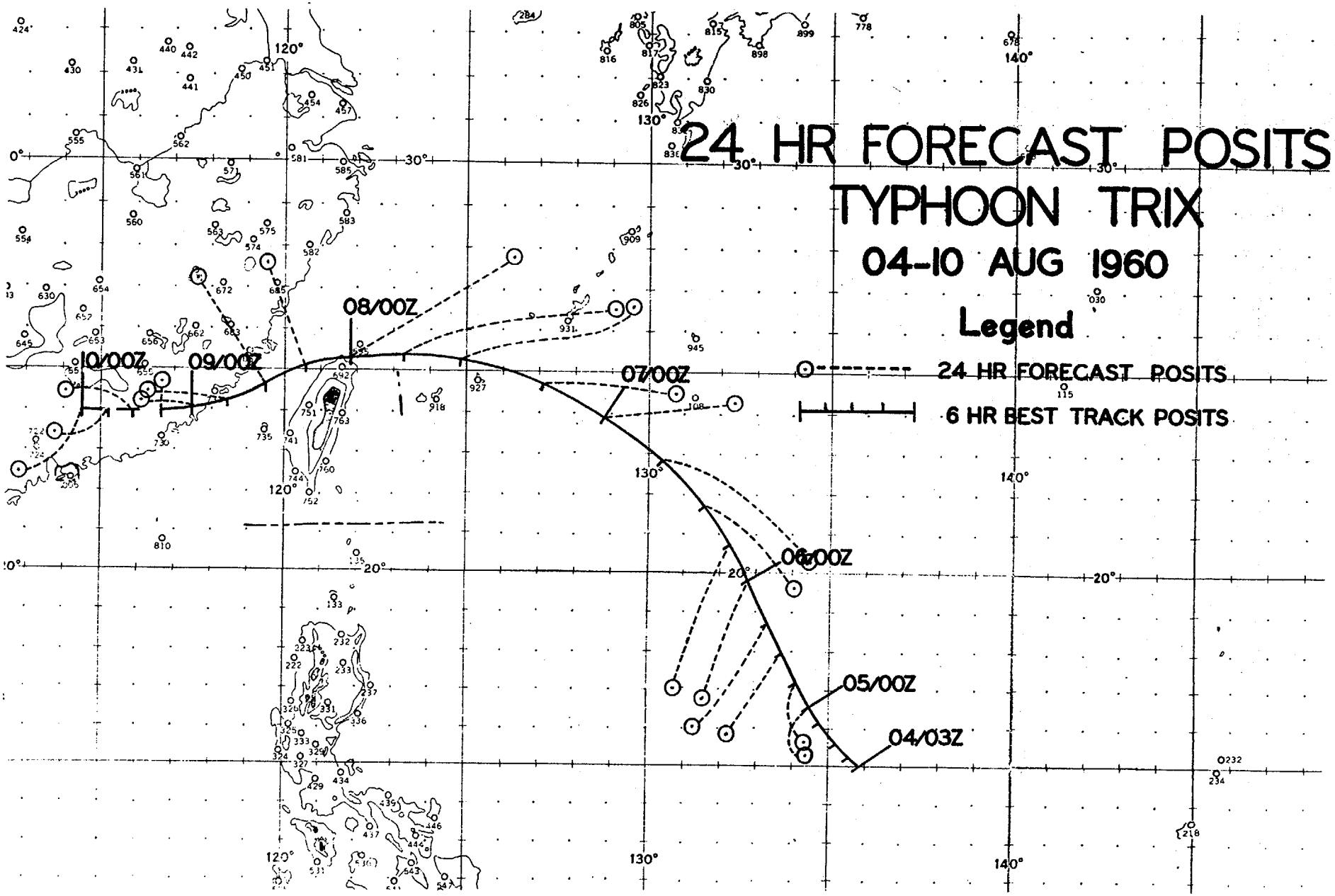
FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	040414Z	13.7N	138.3E	MATS---	- -	30	- - -	- -	- - -	CIRC DIA 40 MI
2	040746Z	15.3N	135.5E	56-P-02	1000	50	9950 (993)	25	10/09	CIRC DIA 60 MI OPEN W
3	042115Z	16.3N	134.7E	56-P-05	985	50	9780 (988)	45	19/09	CIRC DIA 25 MI NO WALL CLDS
4	050900Z	17.4N	134.1E	56-P-10	975	50	9700 (985)	60	16/10	SC SPIRAL BANDS IN EYE
5	052110Z	19.4N	133.1E	56-P-03	975	100	9290 (971)	75	15/09	CIRC DIA 33 MI
6	060300Z	20.3N	132.7E	315-P-02	- -	100	9080 (944)	- -	13/--	ELLIP NW-SE DIA 16 MI
7	060815Z	21.1N	132.1E	56-P-05	935	125	8310 (936)	120	20/14	CIRC DIA 20 MI
8	061556Z	22.5N	130.6E	VW1-R-03	- -	- -	- - -	- -	- - -	SLIGHTLY ELLIP
9	062050Z	23.4N	129.8E	56-P-05	918	120	8130 (930)	100	21/09	CIRC DIA 10 MI
10	070300Z	24.5N	127.9E	315-P-02	- -	130	8210 (933)	70	23/--	CIRC DIA 12 MI
11	070910Z	25.2N	126.0E	56-P-03	- -	120	8440 (911)	110	19/14	CIRC DIA 10 MI
12	071645Z	25.3N	123.6E	VW1-R---	- -	- -	- - -	- -	- - -	POORLY DEFINED
13	072345Z	25.2N	122.1E	56-P-05	958	- -	- - -	*65	- - -	CIRC DIA 30 MI
14	080730Z	25.0N	120.0E	56-R-10	- -	- -	- - -	- -	- - -	EYE WELL DEFINED

* MAX 500 MB WND

TYPHOON TRIX 04-10 AUGUST 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
040300Z	15.0N	135.8E	- - - -		- - - -	
040600Z	15.2N	135.6E	- - - -		- - - -	
041200Z	15.6N	135.2E	- - - -		- - - -	
041800Z	16.1N	134.8E	- - - -		- - - -	
050000Z	16.6N	134.5E	190	89	- - - -	
050600Z	17.2N	134.2E	176	103	- - - -	
051200Z	17.9N	133.8E	218	156	- - - -	
051800Z	18.8N	133.4E	217	210	- - - -	
060000Z	19.8N	132.9E	203	203	199	190
060600Z	20.8N	132.3E	202	247	206	303
061200Z	21.7N	131.6E	133	185	203	349
061800Z	22.9N	130.4E	126	263	209	388
070000Z	23.9N	128.9E	085	183	181	357
070600Z	24.8N	127.1E	097	200	174	432
071200Z	25.2N	124.9E	086	247	105	645
071800Z	25.3N	123.2E	077	320	100	793
080000Z	25.2N	121.9E	055	273	071	717
080600Z	25.1N	120.6E	342	168	069	489
081200Z	24.7N	119.5E	323	180	058	509
081800Z	24.3N	118.5E	268	133	051	601
090000Z	24.1N	117.5E	272	93	037	521
090600Z	24.0N	116.7E	352	54	304	337
091200Z	24.0N	115.9E	282	109	299	400
091800Z	24.0N	115.2E	242	78	265	211
100000Z	24.0N	114.5E	226	132	257	162

AVERAGE 24 HOUR ERROR 173 MI
AVERAGE 48 HOUR ERROR 436 MI

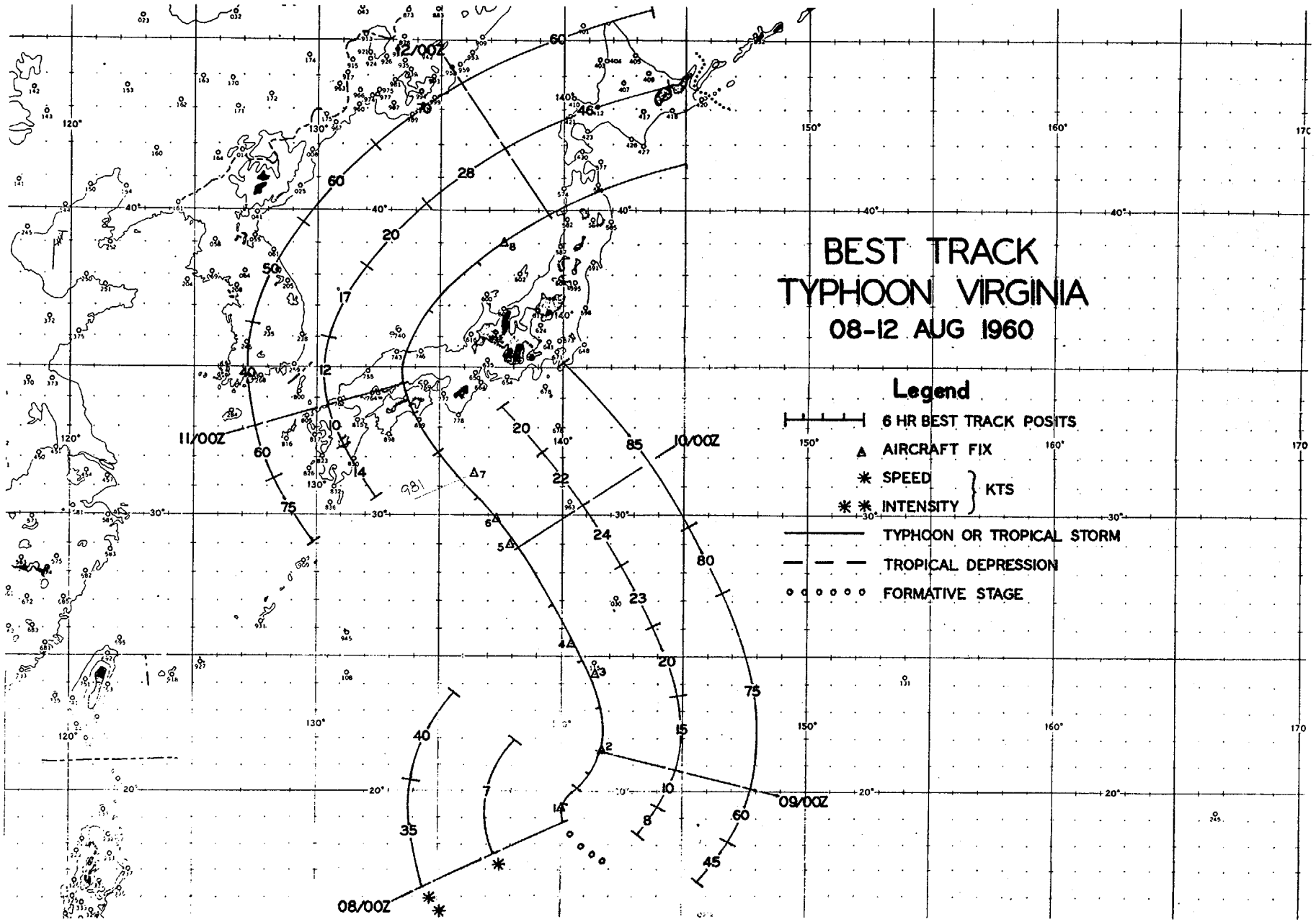

24 HR FORECAST POSITS
TYPHOON TRIX
04-10 AUG 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
10/00Z
09/00Z
08/00Z
07/00Z
06/00Z
05/00Z
04/03Z
120°
130°
140°
0°
20°
30°

I. TYPHOON VIRGINIA (080000Z-120600Z AUGUST 1960)

The birth of VIRGINIA appeared to be on schedule, for cyclones were developing, intensifying and becoming typhoons at the rate of one every 4 to 6 days. This was to increase to a rate of generation of one every 2 to 3 days, but this was unknown to us at the time. The circulation first appeared near 17N 142E, 300 mi NW of Guam on 7 August. It appeared to be forming in the SE sector of Typhoon TRIX, which was about 20 degrees of latitude to the WNW at that time. The first warning indicating 35 kt surface winds was issued at 080000Z, and VIRGINIA became a typhoon 24 hours later. The typhoon passed 20 mi to the W of Iwo Jima at 091100Z with 75 kt surface winds near the center, and 30 hours later it was 10 mi from the island of Shikoku, Japan. VIRGINIA passed over southern Japan into the Sea of Japan and then returned over northern Honshu 18 hours later. VIRGINIA weakened as it passed over Japan the first time, then rapidly intensified to typhoon strength again at the surface. The second passage over Japan effectively destroyed the circulation as a typhoon. VIRGINIA became extratropical by 120600Z, and the last warning was issued at this time.

This circulation was characterized by rapid intensification and a high speed of movement, for the average speed throughout its life was 18 kts or 432 mi per day. VIRGINIA traveled 1850 mi in 4 days and 6 hours. The minimum speed was 7 kts on 8 August, and the maximum speed was 46 kts on 12 August.

Except for its speed of movement and intensification, Typhoon VIRGINIA had no unusual features. The 200 mb wind circulation did not indicate a closed system while VIRGINIA was in the proximity of Japan, but a low may have been closed while VIRGINIA was near Iwo Jima. The 300 mb chart indicated that there was a closed cyclonic circulation through that level while VIRGINIA was near Iwo Jima and as it initially approached Japan.


BEST TRACK
TYPHOON VIRGINIA
08-12 AUG 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
12/00Z
11/00Z
10/00Z
09/00Z
08/00Z

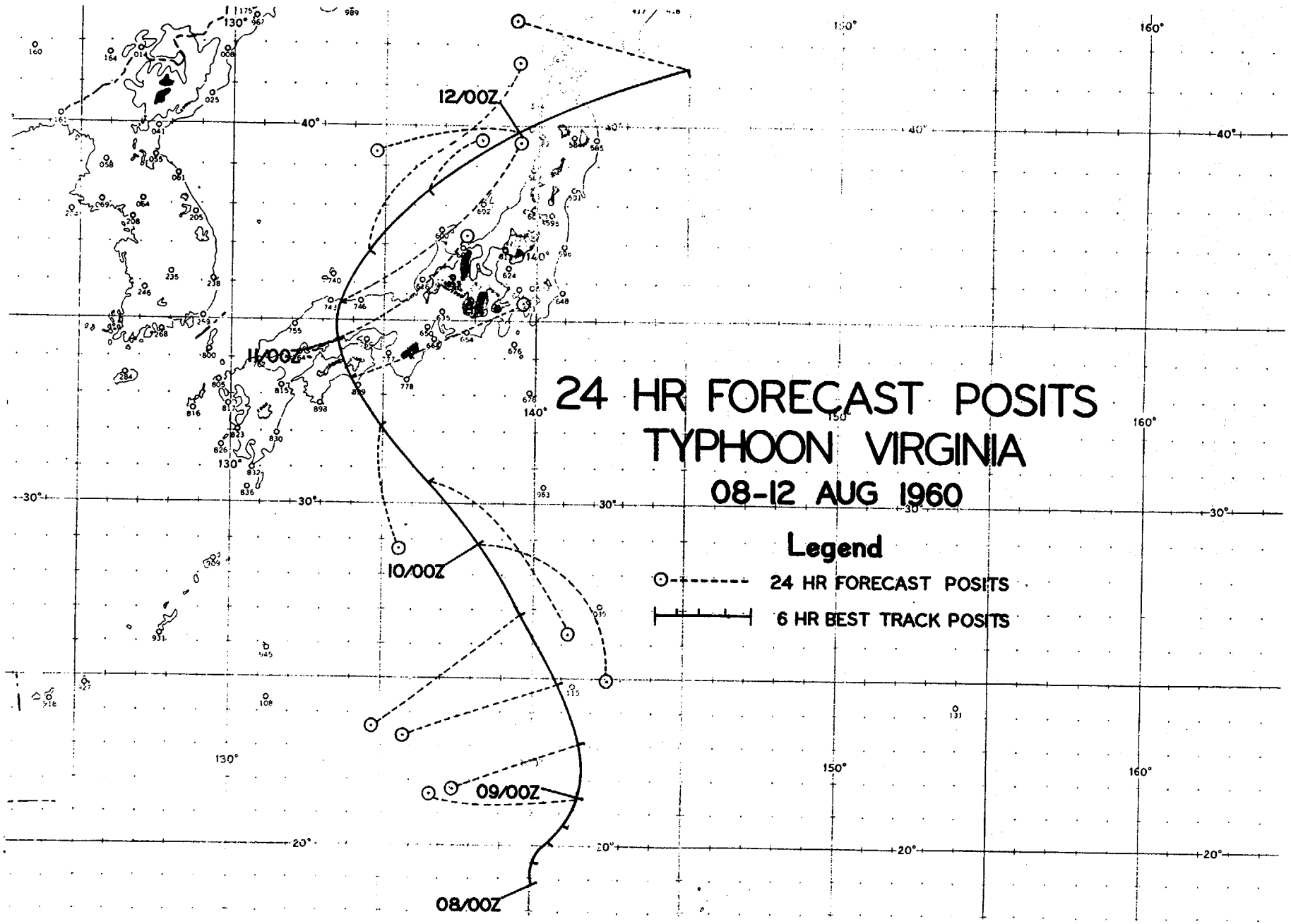
RECONNAISSANCE AIRCRAFT FIXES - TYPHOON VIRGINIA

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	080345Z	19.3N	140.0E	56-P---	- -	25	- - -	- -	- - -	ELLIP 10X19 MI
2	082345Z	21.5N	141.7E	56-P-05	998	110	9680	55	16/10	U SHAPED 40-50MI DIA WELL DEFINED
3	090940Z	24.3N	141.3E	56-P-01	987	70	10030	60	14/09	CIRC DIA 100 MI
4	091535Z	26.4N	140.3E	VW1-R-05	- -	- -	- - -	- -	- - -	OPEN S
5	100030Z	29.0N	137.9E	56-P-05	984	75	9690	50	14/10	CIRC DIA 20 MI OPEN N
6	100300Z	29.9N	137.2E	56-P-03	981	100	9650	85	14/10	INDEFINITE, 35 MI DIA
7	100800Z	31.4N	136.3E	56-P-05	971	75	9590	70	13/10	ILL-DEFINED, OPEN S
8	112100Z	39.0N	137.6E	56-P-01	999	65	10040	70	16/08	NOT CLEARLY DEFINED

TYPHOON VIRGINIA 08-12 AUGUST 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
080000Z	18.9N	140.1E	- - - -	- - - -
080600Z	19.5N	140.1E	- - - -	- - - -
081200Z	20.1N	140.6E	- - - -	- - - -
081800Z	20.7N	141.2E	- - - -	- - - -
090000Z	21.6N	141.7E	- - - -	- - - -
090600Z	23.1N	141.7E	- - - -	- - - -
091200Z	24.9N	140.9E	250-304	- - - -
091800Z	26.9N	139.7E	233-334	- - - -
100000Z	28.9N	138.1E	154-347	- - - -
100600Z	30.6N	136.5E	138-367	- - - -
101200Z	32.2N	135.0E	174-206	215-518
101800Z	33.3N	133.9E	066-326	199-536
110000Z	34.3N	133.5E	051-274	126-447
110600Z	35.4N	133.6E	- - - -	- - - -
111200Z	36.9N	134.5E	- - - -	- - - -
111800Z	38.3N	136.4E	- - - -	- - - -
120000Z	39.9N	139.3E	- - - -	- - - -
120600Z	41.4N	145.0E	- - - -	- - - -

AVERAGE 24 HOUR ERROR 308 MI
AVERAGE 48 HOUR ERROR 500 MI


24 HR FORECAST POSITS
TYPHOON VIRGINIA
08-12 AUG 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
12/00Z
11/00Z
10/00Z
09/00Z
08/00Z

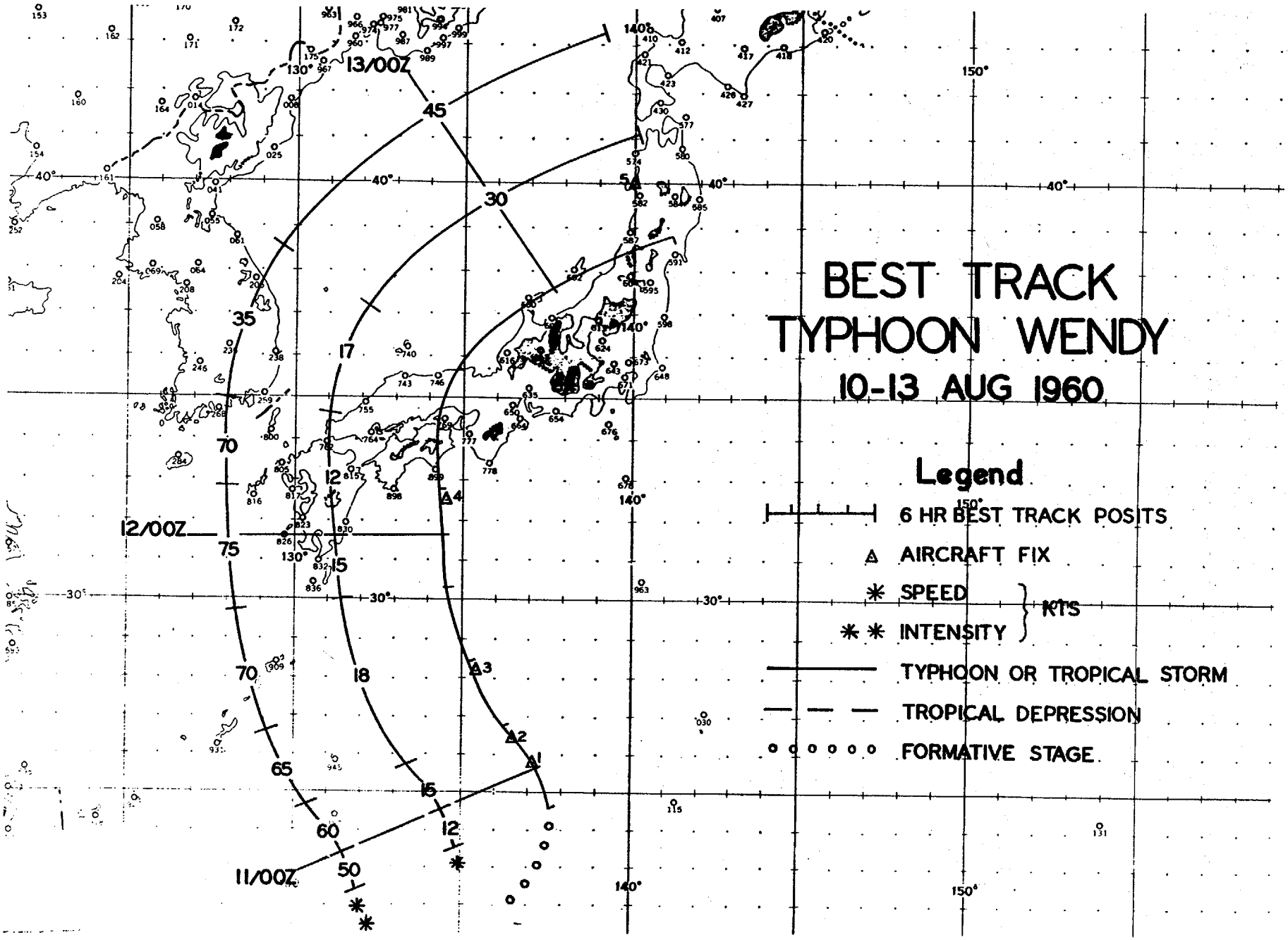
J. TYPHOON WENDY (101800Z-130600Z AUGUST 1960)

Typhoon WENDY might be considered as an offspring of Typhoon VIRGINIA, for at 100600Z the winds near the edge of VIRGINIA's circulation, about 500 mi S of VIRGINIA, did not correspond to the circulation that is expected with a typhoon. The area became suspect and 12 hours later the first warning was issued on T.S. WENDY, located 205 mi W of Iwo Jima, with surface winds of 50 kts. Based on reconnaissance, the 110000Z warning was issued with 65 kt surface winds. Thus WENDY became a typhoon at that time; however, post analysis indicates that WENDY did not have typhoon winds until 110600Z. Typhoon WENDY intensified to 75 kts and moved rapidly to the island of Shikoku, Japan. This typhoon moved inland at 120800Z, just 20 mi E of the point along the coast of Shikoku that VIRGINIA had passed 39 hours before. WENDY remained over land for 10 hours, weakening from 70 to 35 kts at the surface. It again intensified to 45 kts while in the Sea of Japan and then moved inland over northern Honshu at 130300Z. The last warning was issued at 130600Z when it became apparent that WENDY was no longer a hazard.

Examination of the 110000Z charts from the surface through the 200 mb level suggests that Typhoon WENDY was almost under a low circulation at time of development into a typhoon. This implies that divergence was slight or non-existent in the levels near 300 and 200 mb. This cyclonic circulation at 300 and 200 mb did not progress along with WENDY but remained near Iwo Jima. Based on available data, the cyclonic circulation of the typhoon never reached the 300 mb level.

WENDY traveled 1050 mi in 2 and one half days at an average speed of 18 kts or 426 mi per day. The typhoon moved at a minimum speed of 12 kts on 10 August, and a maximum speed of 30 kts on 13 August. WENDY was a typhoon for only 30 hours.

The apparent formation of Typhoon WENDY within the circulation of Typhoon VIRGINIA, under what appeared to be an area of non-divergence, represents an unusual feature of typhoon development.


BEST TRACK
TYPHOON WENDY
10-13 AUG 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
13/00Z
12/00Z
11/00Z
45
30
35
17
70
12
75
15
70
18
65
15
60
12
50
140°
150°
40°
30°
130°

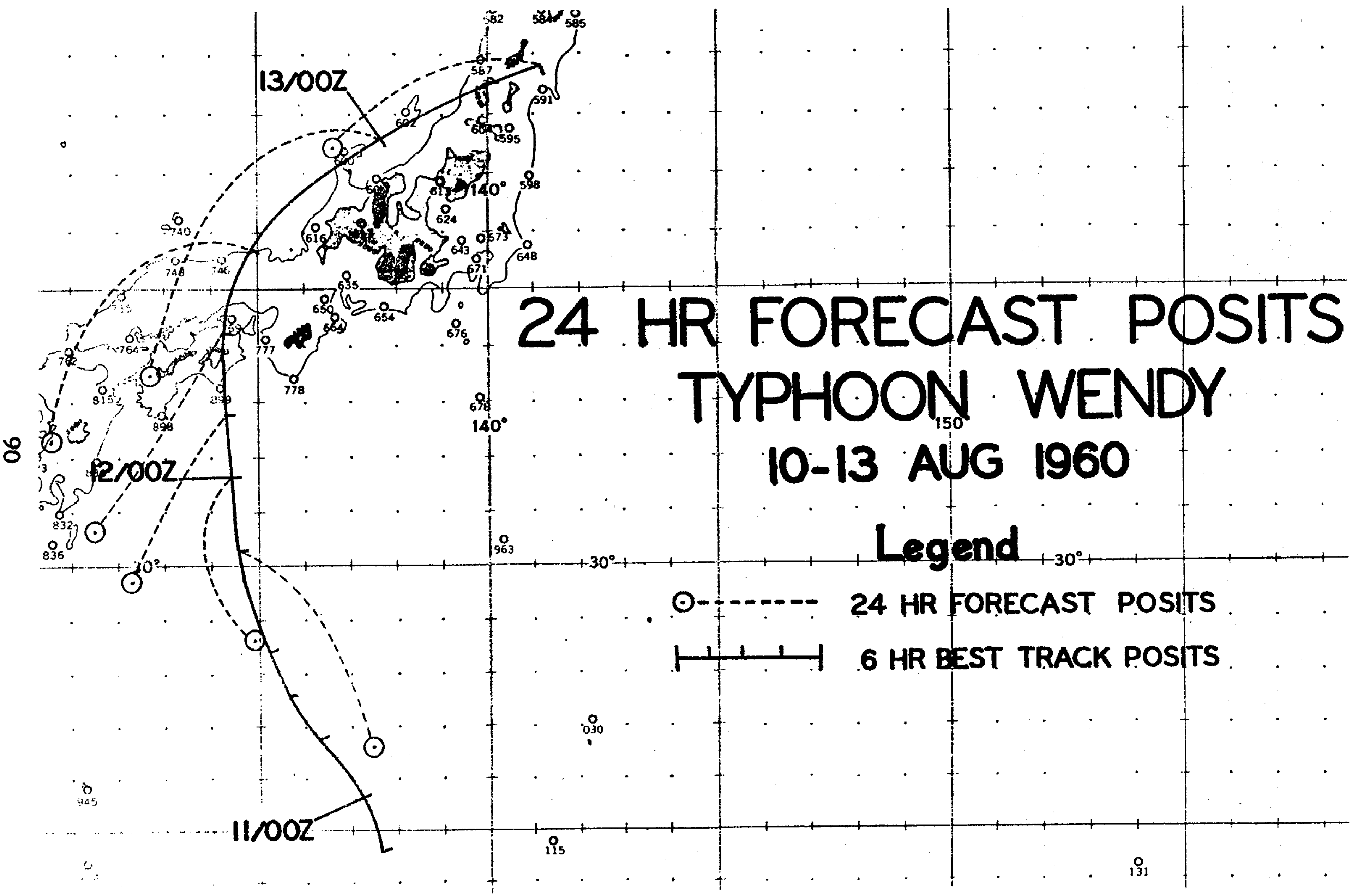
RECONNAISSANCE AIRCRAFT FIXES - TYPHOON WENDY

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	110030Z	25.8N	137.1E	56-P-08	1000	75	10060 998	55	15/07	CIRC DIA 40 MI OPEN NW
2	110400Z	26.4N	136.5E	56-P-08	986	65	10030 997	50	14/09	CIRC DIA 30 MI
3	111008Z	28.1N	135.3E	315-P-02	- -	70	9960 994	- -	16/--	CIRC DIA 40 MI POORLY DEFINED
4	120310Z	32.3N	134.3E	VW1-R---	- -	- -	- - -	- -	- - -	- - - - - - - - - - - - - - -
5	120800Z	40.0N	140.0E	315-R---	- -	- -	- - -	- -	- - -	NO CLOSED CIRCULATION

TYPHOON WENDY 10-13 AUGUST 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
101800Z	24.6N	137.6E	- - - -	- - - -
110000Z	25.7N	137.2E	- - - -	- - - -
110600Z	26.8N	136.2E	- - - -	- - - -
111200Z	28.4N	135.1E	- - - -	- - - -
111800Z	30.3N	134.5E	145-265	- - - -
120000Z	31.7N	134.4E	175-228	- - - -
120600Z	32.8N	134.2E	210-214	- - - -
121200Z	34.1N	134.1E	214-253	- - - -
121800Z	35.7N	134.9E	- - - -	- - - -
130000Z	37.6N	137.7E	- - - -	- - - -
130600Z	38.9N	141.1E	- - - -	- - - -

AVERAGE 24 HOUR ERROR 240 MI


24 HR FORECAST POSITS
TYPHOON WENDY
10-13 AUG 1960
13/00Z
12/00Z
11/00Z
140°
150
30°
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS

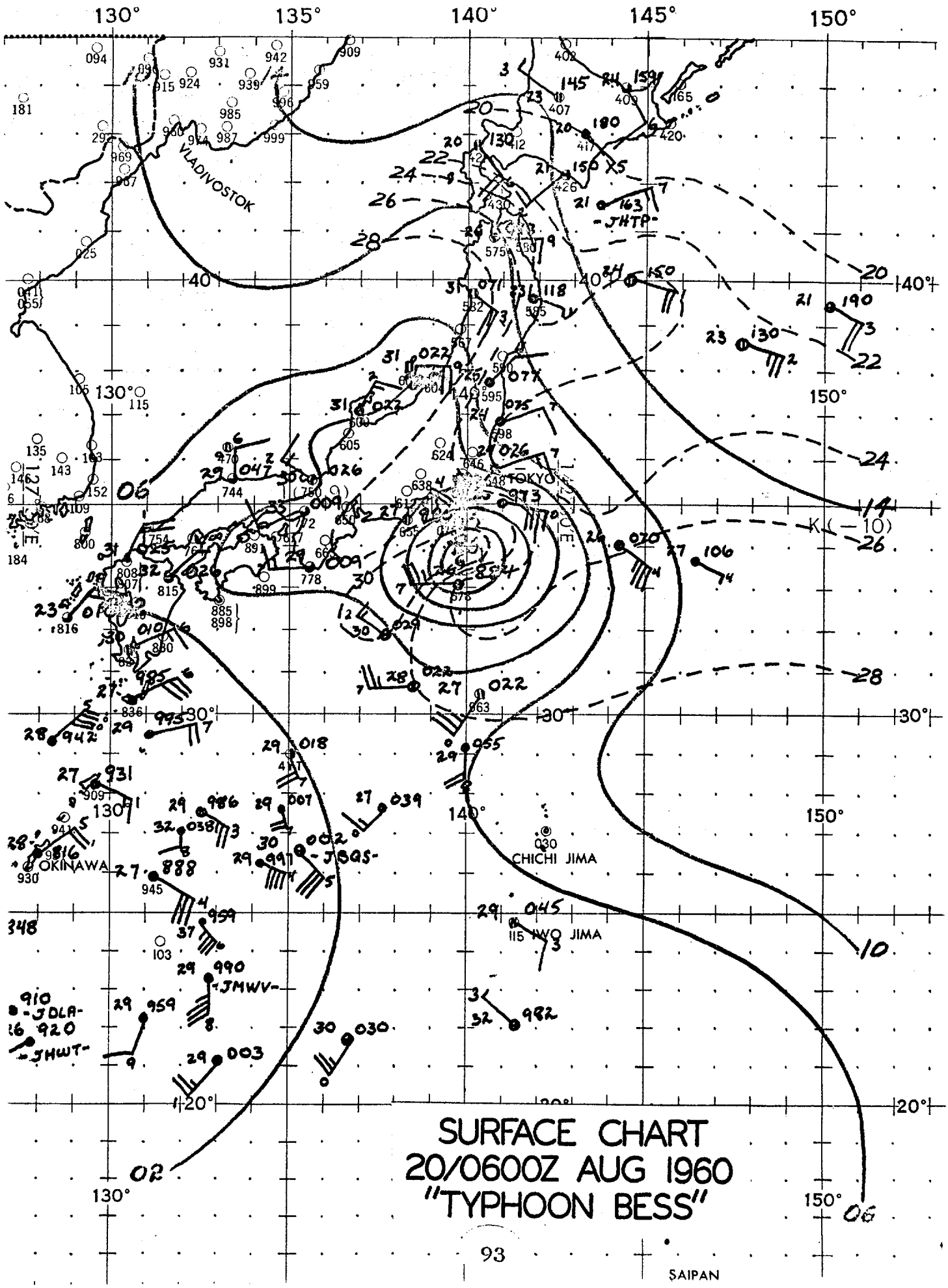
K. TYPHOON BESS (160900Z-251200Z AUGUST 1960)

The first indication of Typhoon BESS was a small circulation on the 130600Z surface chart about 750 mi to the ESE of T.S. AGNES and about 375 mi NW of Guam. A second cyclone, later to become Typhoon CARMEN, developed simultaneously with BESS even closer to AGNES. As these two cyclones developed, the trough extending to the SE from AGNES gradually assumed an E-W orientation and by 141200Z extended 3,000 mi to the E (from 100E to 146E) along latitude 22N. Upon becoming parallel latitudinally the trough began to intensify, and on the 141200Z surface chart the pressure in the trough averaged 1002 mb (an average of all isobars crossing the trough line from 100E to 146E). By 151200Z the trough's pressure averaged 999 mb. During the period 130600Z to 160600Z the depression that was to become BESS moved slowly, intensified with the trough, and increased to tropical storm intensity at 160900Z when the first warning was issued. BESS then moved on a track of 310 degrees to a point 115 mi NNE of Iwo Jima at 180600Z, and at 181200Z to a point 30 mi SW of Peel Island. It then curved to the NNW and passed 40 mi WSW of Tori Shima at 190900Z. BESS was upgraded to a typhoon at 200000Z, although post analysis indicates that it reached typhoon intensity at approximately 191800Z. As a typhoon it passed 25 mi E of Miyake Jima, an island 100 mi S of Tokyo, at 200900Z, and within 25 mi of the main island of Honshu while moving to the NE. At 37N 145E BESS commenced moving on a track of 100 degrees. The typhoon continued along this track until 221800Z when it began reversing direction, moving clockwise and forming a loop. The N-S axis of the loop was 50 mi and the E-W axis 175 mi. BESS intersected the original track at 35.8N 152.0E while moving WNW. Typhoon BESS was downgraded to a tropical storm at 240600Z, and the final warning was issued at 251200Z. Post analysis indicates that BESS should have been downgraded to a tropical storm at approximately 230600Z. Typhoon BESS moved 2200 mi in 9 days and 3 hours at an average speed of 10 kts or 243 mi per day.

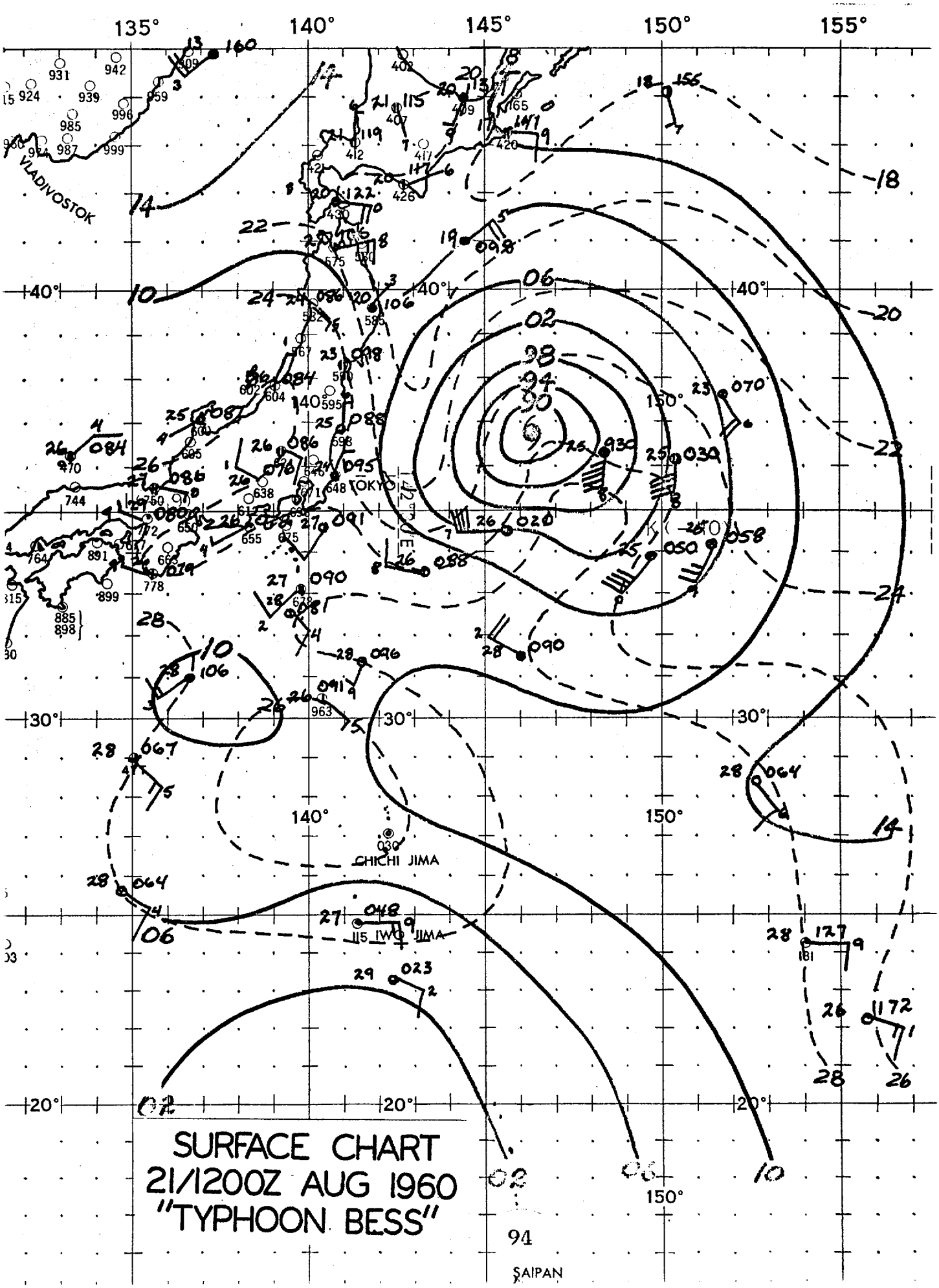
By 161200Z, the large surface trough, previously discussed, extended between 20 and 25 degrees N and from approximately 100 to 152E. The ridge line at this time was N of 40N from Japan to Hawaii, and the pressure along the equator averaged approximately 1010 mb - the contribution of a series of small highs just N of the equator. The easterlies, disturbed more than usual, lacked the normally smooth pattern. From 20S to 30N easterlies existed from E of Hawaii to 155E. From 100E to 150E westerlies of substantial strength existed from

near the equator to 20N. During the period that warnings were issued on BESS the following typhoons and tropical storms existed: T.S. AGNES, Typhoon CARMEN, Typhoon ELAINE, Typhoon DELLA, and T.S. FAYE (later to become a typhoon).

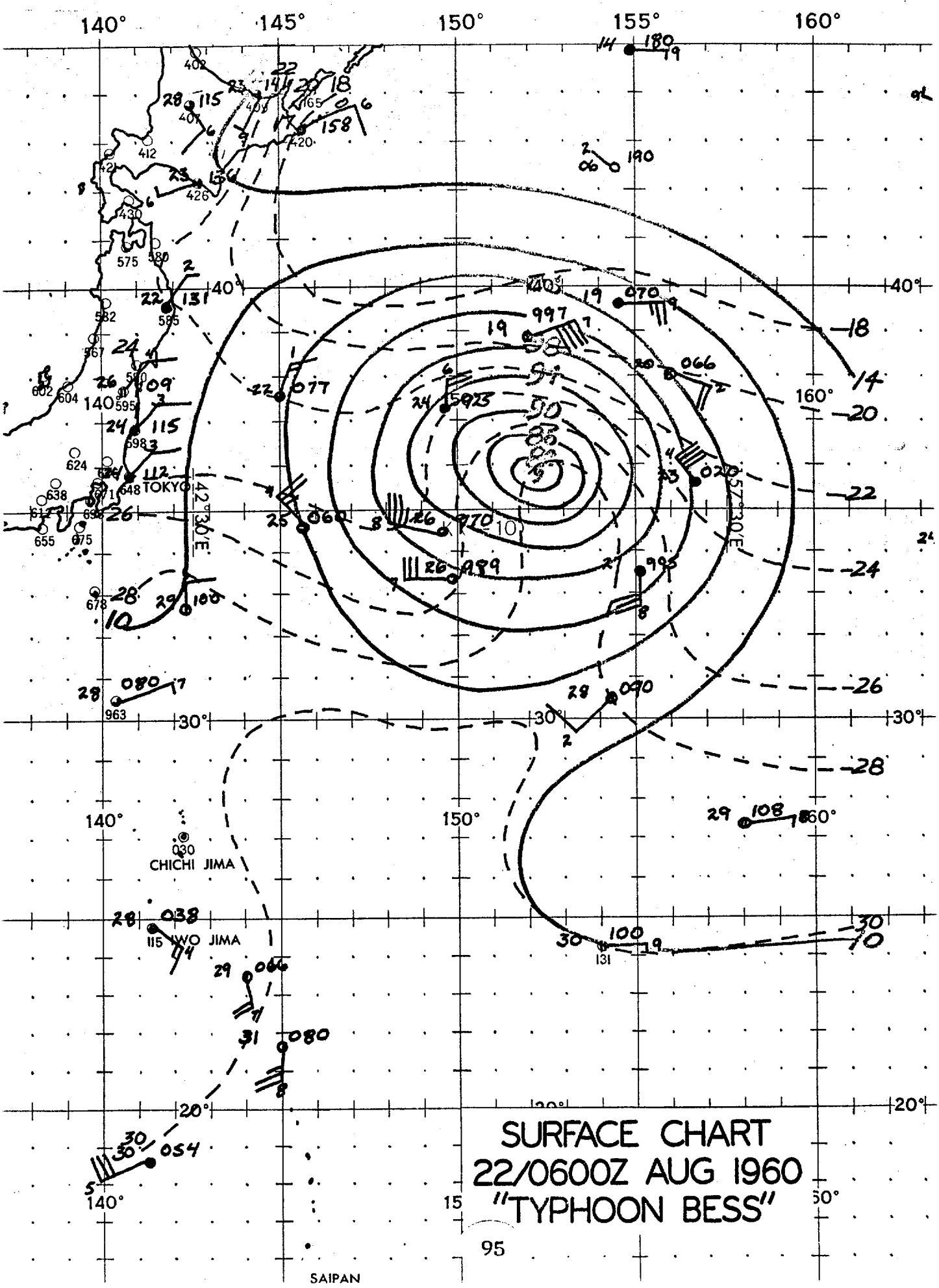
There are two features about Typhoon BESS that appear unusual. The first is the loop that occurred. A loop was not uncommon during the 1960 Typhoon Season, however, no typhoons looped in 1959, and only one tropical storm and one typhoon looped during the 1958 season. Coincidental with the arrival of BESS off the E coast of Japan, an upper air trough, best pictured on the 300 mb chart, developed between a high centered over southern Japan and one at 28N 150E. The easternmost high moved further SE and the trough deepened rapidly at a point almost over Typhoon BESS. Between 221200Z and 231200Z a closed circulation formed in this trough at a point S of the surface position of BESS. This circulation then caused BESS to commence moving in a westerly direction. BESS was then influenced by the circulation around a deep low near 45N 128E which caused it to move to the N after 250600Z. The other feature is the continued life of BESS after 201200Z. It is believed that BESS would have become extratropical after 201200Z had it not been for the circulation about T.S. DELLA and later around T.S. FAYE transporting warm air into the vicinity of Typhoon BESS, prolonging its life about 4 days. During this period, there was warm air at the center from the surface through the 500 mb level. Included are 4 surface charts with pressure and temperature analyses portraying the conditions at that time. Limited data precludes a more detailed examination.

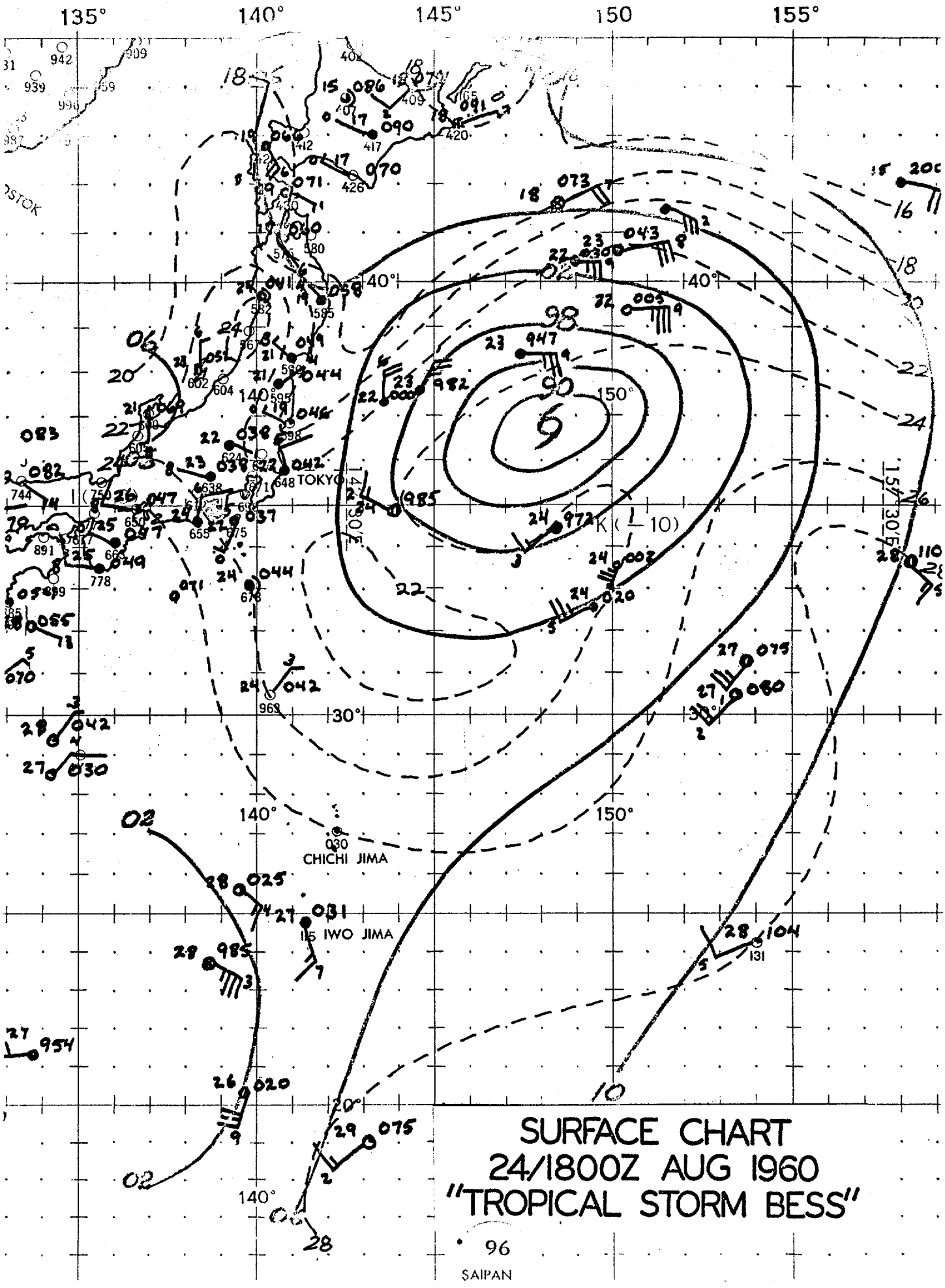


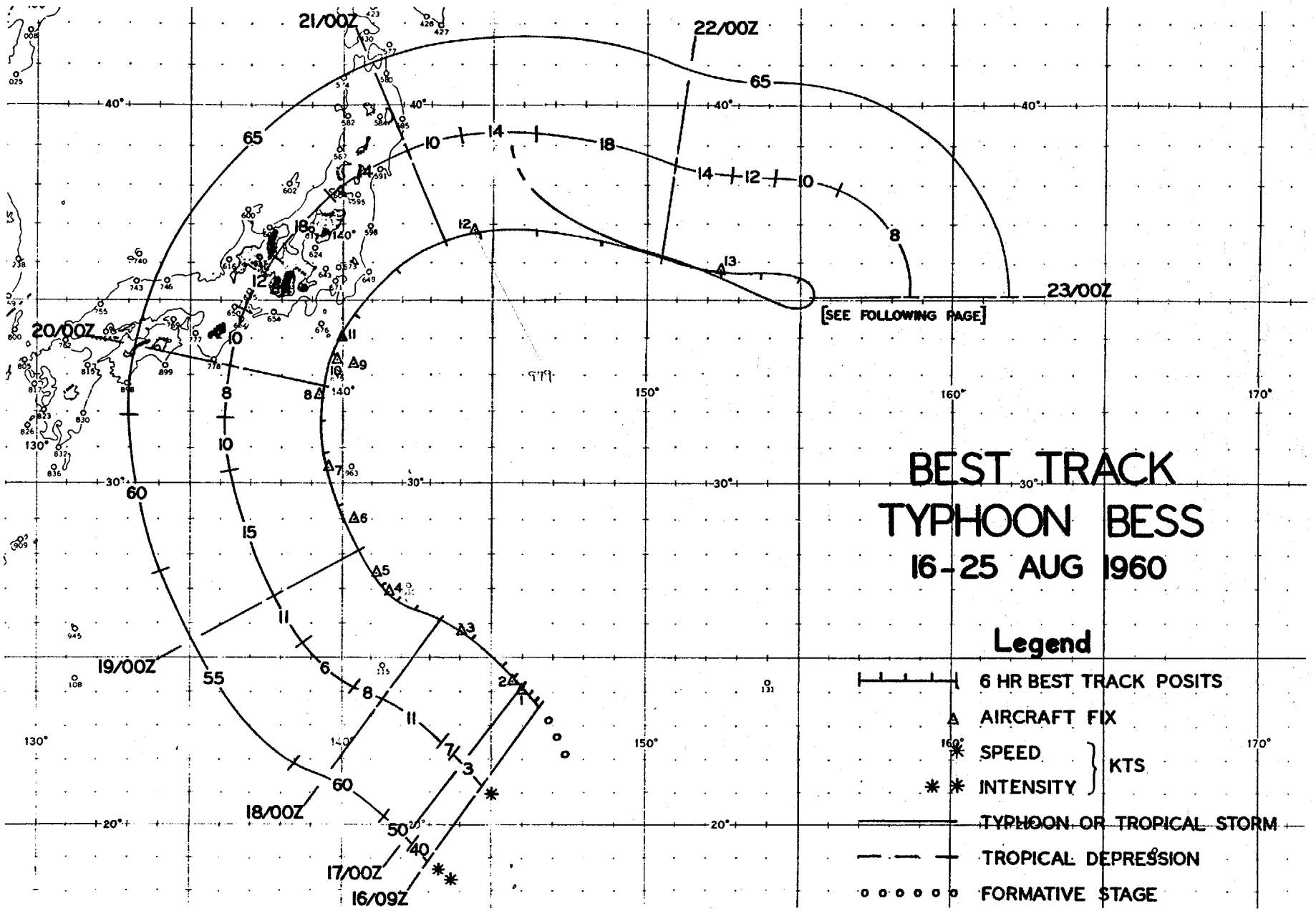
SURFACE CHART
20/0600Z AUG 1960
"TYPHOON BESS"

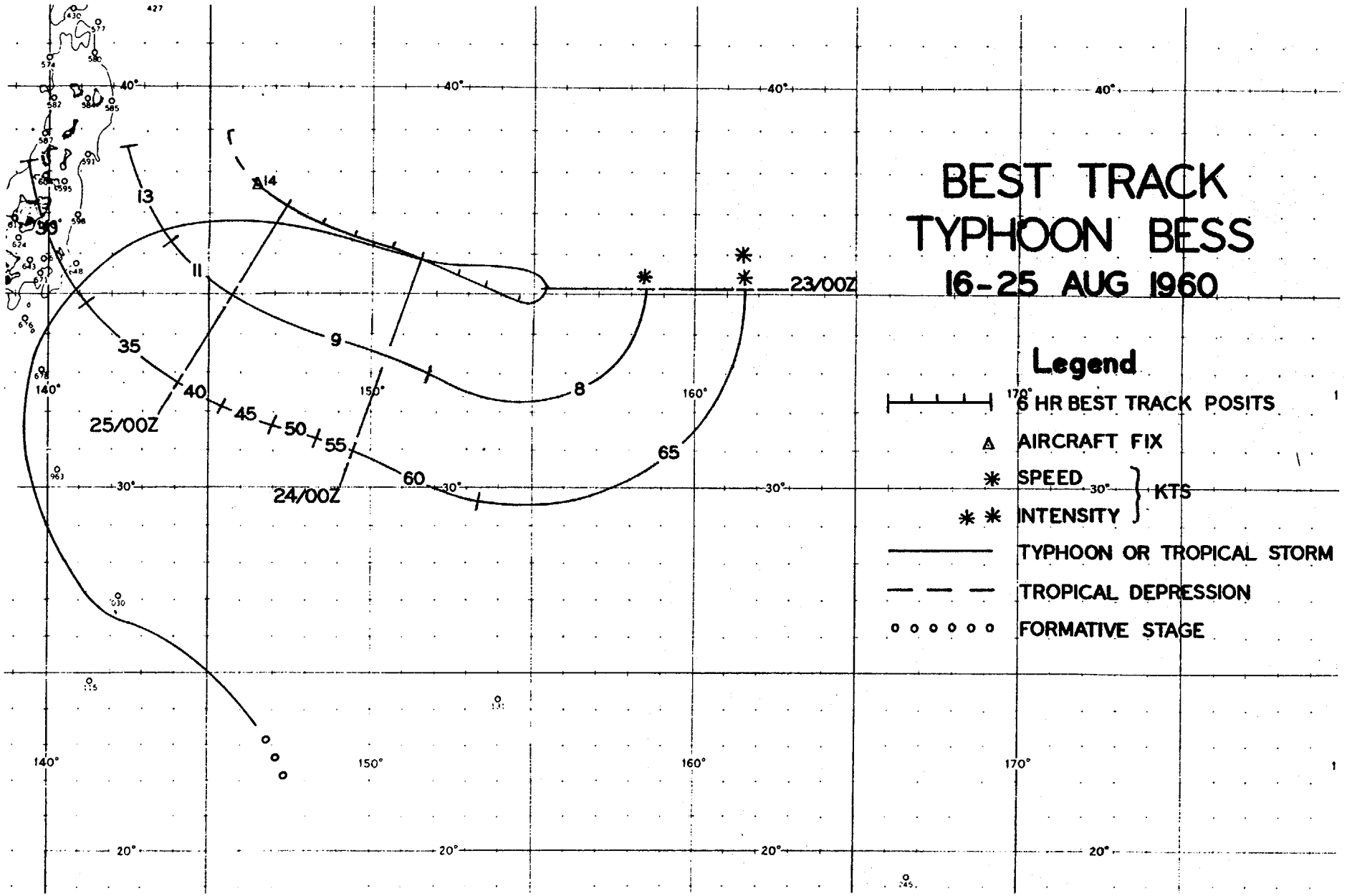


SURFACE CHART
21/1200Z AUG 1960
"TYPHOON BESS"


140°
145°
150°
155°
160°
40°
30°
20°
TOKYO
CHICHI JIMA
IWO JIMA
SAIPAN
SURFACE CHART
22/0600Z AUG 1960
"TYPHOON BESS"


135°
140°
145°
150
155°
40°
30°
20°
TOKYO
CHICHI JIMA
IWO JIMA
SAIPAN
SURFACE CHART
24/1800Z AUG 1960
"TROPICAL STORM BESS"


21/00Z
22/00Z
23/00Z
20/00Z
19/00Z
18/00Z
17/00Z
16/09Z
[SEE FOLLOWING PAGE]
BEST TRACK
TYPHOON BESS
16-25 AUG 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE


BEST TRACK
TYPHOON BESS
16-25 AUG 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
23/00Z
25/00Z
24/00Z
13
14
11
9
8
35
40
45
50
55
60
65
40°
30°
20°
140°
150°
160°
170°

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON BESS

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	170010Z	24.1N	145.9E	56-P-20	980	45	9830 (990)	40	12/10	CIRC DIA 05 MI WELL DEFINED
2	170600Z	24.3N	145.8E	56-P-05	990	55	9810 (987)	50	13/10	CIRC DIA 05 MI OPEN W
3	171948Z	25.7N	144.0E	56-P-08	958	- -	9780 (988)	30	10/08	CIRC DIA 12 MI
4	180800Z	26.9N	141.6E	56-P-05	990	35	9850 (990)	35	10/07	ELLIP ORIEN N-S DIFFUSE
5	182015Z	27.4N	141.1E	56-P-05	984	45	9640 (983)	35	13/10	CIRC DIA 10 MI OPEN S
6	190350Z	29.0N	140.3E	VW1-R-10	- -	- -	- - -	- -	- - -	CIRC DIA 12 MI
7	190935Z	30.4N	139.6E	56-P-01	942	55	9670 (974)	51	16/12	CIRC DIA 16 MI OPEN S
8	192155Z	32.4N	139.1E	56-P-02	980	55	9650 (983)	60	18/--	CIRC DIA 15 MI
9	200203Z	33.4N	140.3E	USN-R-01	- -	- -	- - -	- -	- - -	HORSE SHOE EYE 70 MI DIA
10	200515Z	33.3N	139.9E	56-P-02	978	55	9720 (986)	50	18/13	CIRC DIA 20 MI OPEN SE
11	200820Z	34.0N	140.0E	315-----	- -	60	9610 (982)	30	16/--	- - - - - - - - - - - - - - -
12	210500Z	36.9N	144.4E	56------	- -	60	9500 (971)	40	15/--	NO EYE
13	220600Z	35.8N	152.3E	315-P-08	- -	60	- - -	*66	14/--	- - - - - - - - - - - - - - -
14	250509Z	37.7N	146.4E	56-P-04	986	20	- - -	- -	- - -	EXTRATROPICAL

* MAX 500 MB WND

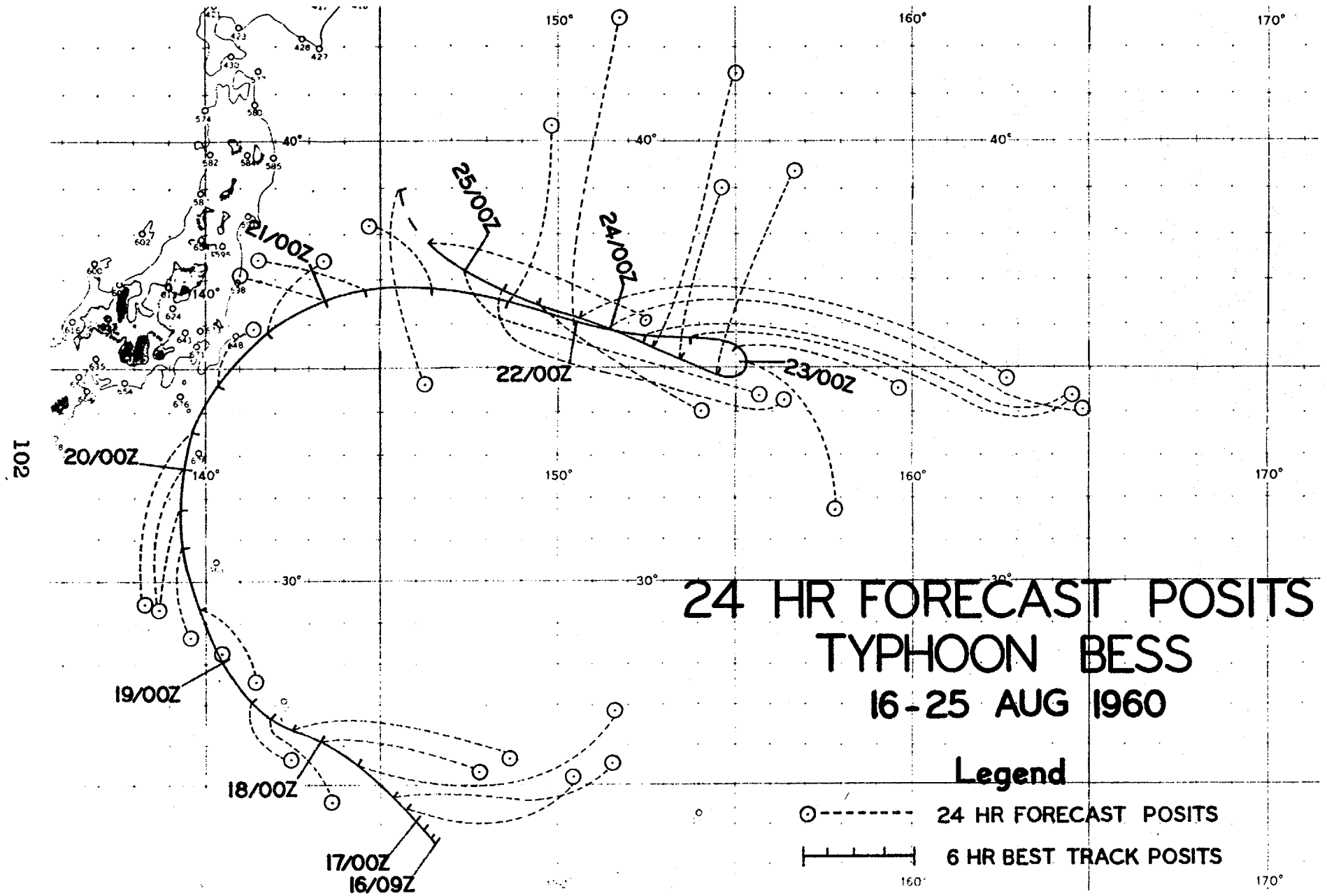
TYPHOON BESS 16-25 AUGUST 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
160900Z	23.5N	146.5E	- - - -	- - - -
161200Z	23.6N	146.4E	- - - -	- - - -
161800Z	23.8N	146.2E	- - - -	- - - -
170000Z	24.1N	146.0E	- - - -	- - - -
170600Z	24.3N	145.8E	079-246	- - - -
171200Z	24.8N	145.3E	082-344	- - - -
171800Z	25.5N	144.3E	078-403	- - - -
180000Z	26.1N	143.2E	102-257	- - - -
180600Z	26.4N	142.5E	097-342	081-688
181200Z	26.7N	141.9E	142-220	079-767
181800Z	27.1N	141.3E	148-101	075-807
190000Z	28.1N	140.6E	301-12	092-520
190600Z	29.4N	139.9E	148-132	105-613
191200Z	30.9N	139.4E	173-135	161-340
191800Z	31.8N	139.2E	190-157	181-312
200000Z	32.7N	139.2E	187-212	198-181
200600Z	33.6N	139.7E	196-254	186-273
201200Z	34.6N	140.5E	065-51	214-298
201800Z	35.9N	141.9E	- - - -	- - - -
210000Z	36.6N	143.4E	- - - -	- - - -
210600Z	36.9N	144.6E	- - - -	- - - -
211200Z	36.9N	146.3E	- - - -	- - - -
211800Z	36.6N	148.5E	- - - -	- - - -
220000Z	36.1N	150.5E	- - - -	- - - -
220600Z	35.8N	152.3E	- - - -	- - - -
221200Z	35.8N	153.8E	- - - -	- - - -
221800Z	35.7N	155.0E	- - - -	- - - -
230000Z	35.1N	155.4E	- - - -	- - - -
230600Z	34.9N	154.5E	- - - -	- - - -
231200Z	35.2N	153.6E	- - - -	- - - -
231800Z	35.5N	152.7E	- - - -	- - - -
240000Z	35.9N	151.6E	- - - -	- - - -
240600Z	36.1N	150.6E	- - - -	- - - -
241200Z	36.4N	149.5E	- - - -	- - - -
241800Z	36.7N	148.4E	- - - -	- - - -

TYPHOON BESS 16-25 AUGUST 1960
POSITION AND FORECAST VERIFICATION DATA (CONT'D)

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
250000Z	37.1N	147.4E	- - - -		- - - -	
250600Z	37.8N	146.3E	- - - -		- - - -	
251200Z	39.0N	145.7E	- - - -		- - - -	

AVERAGE 24 HOUR ERROR 205 MI
AVERAGE 48 HOUR ERROR 480 MI


150°
160°
170°
40°
30°
140°
102
16/09Z
17/00Z
18/00Z
19/00Z
20/00Z
21/00Z
22/00Z
23/00Z
24/00Z
25/00Z
24 HR FORECAST POSITS
TYPHOON BESS
16-25 AUG 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS

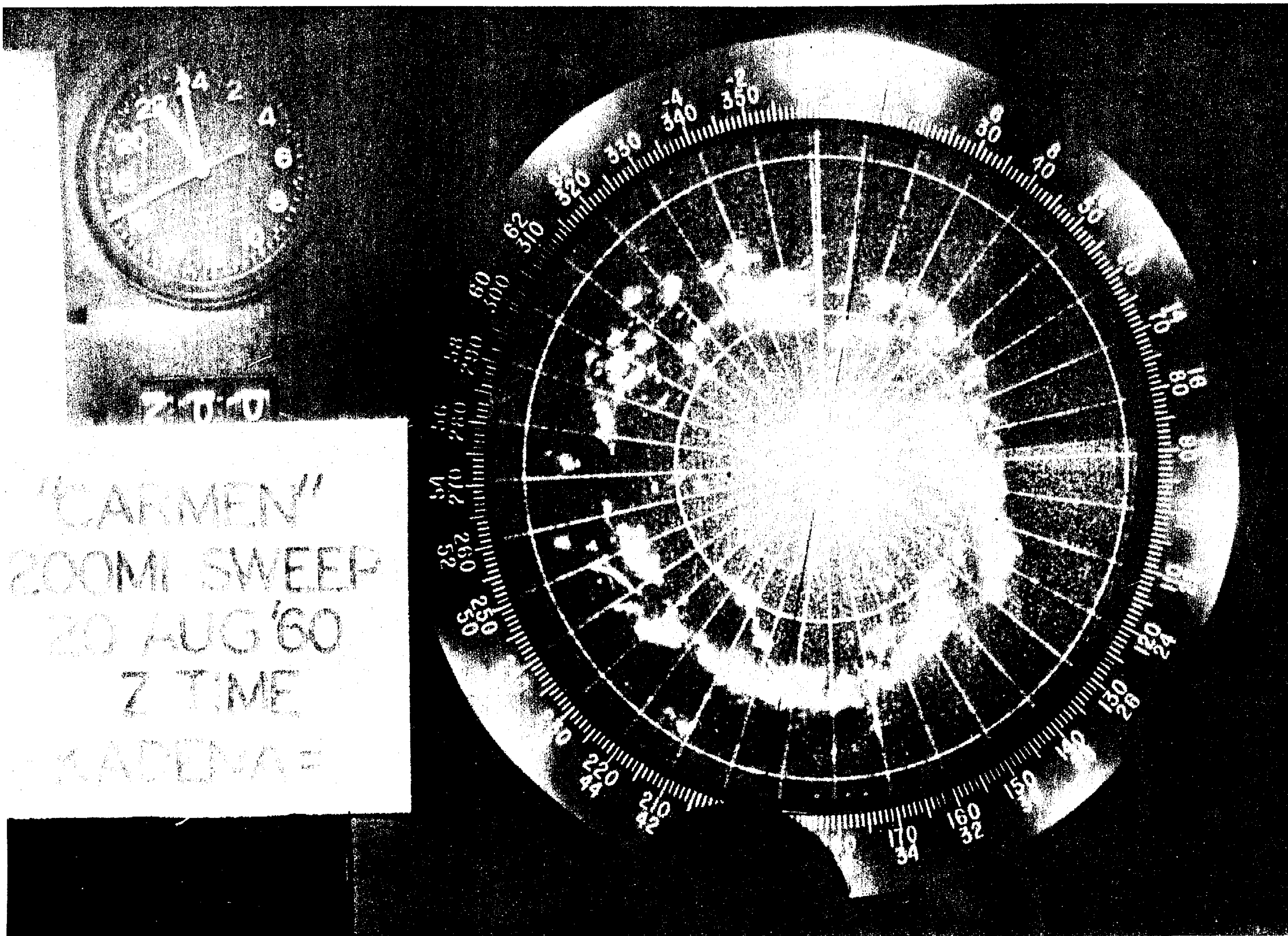
L. TYPHOON CARMEN (160000Z-240000Z AUGUST 1960)

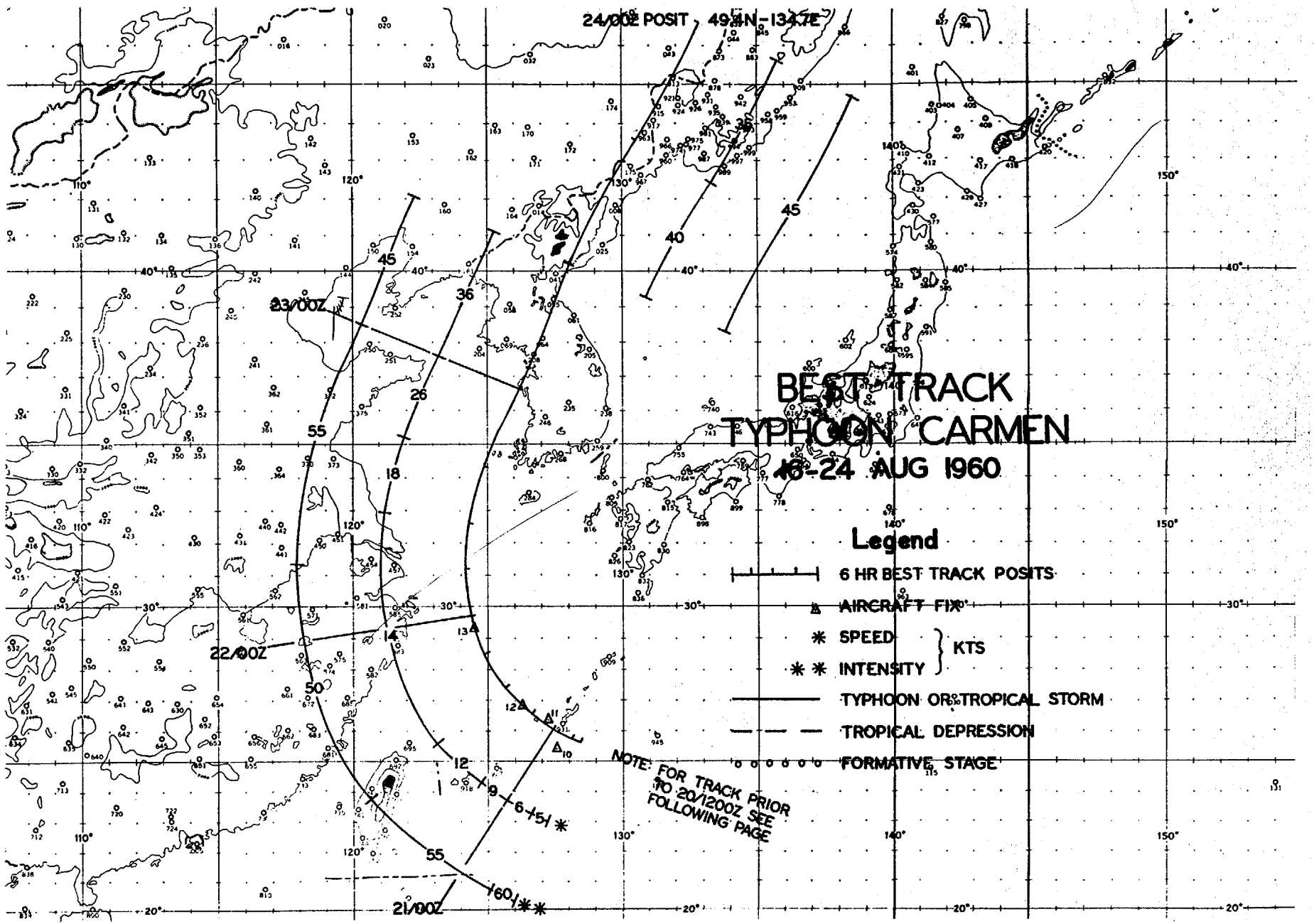
A sharp trough was evident to the SE of T.S. AGNES, and when it became apparent that the winds were stronger 500 mi SE of AGNES than near its center, the development of another tropical storm or typhoon was indicated. At 160000Z the first T.D. warning was issued, and 12 hours later the T.D. was upgraded to T.S. CARMEN. CARMEN became a typhoon at 171200Z when it was about 125 mi SSW of Okinawa. The typhoon moved at an average speed of 3 kts along an inverted "S" track until it approached the S end of Okinawa from the SE. When it was 50 mi SE of Okinawa, CARMEN was downgraded to a T.S. The storm then moved NW until reaching 30N where it recurved, accelerated, and moved NNE, passing 140 mi E of Shanghai at 220600Z and 20 mi W of Seoul, Korea at 230200Z.

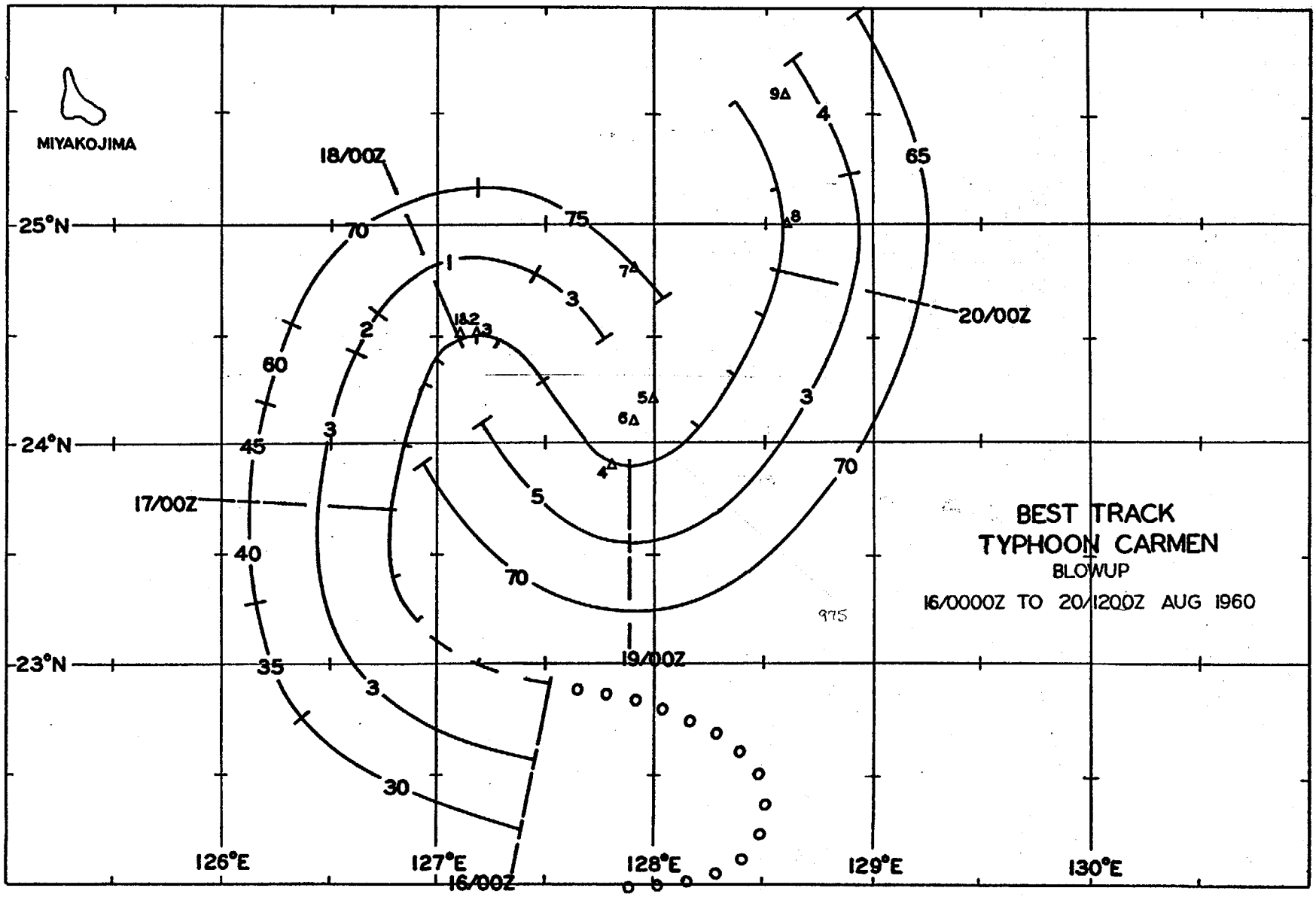
At the time it passed over Korea, CARMEN was moving at 36 kts and carried maximum winds of 45 kts. Typhoon CARMEN was large, about 800 mi in diameter, covering an area of more than 500,000 square mi, and it extended through 45,000 ft on 19 August. Another feature quite unusual about this typhoon was the diameter of its eye. Reconnaissance aircraft frequently reported eye diameters of 100 mi, using as the basis of measurement, surface winds and pressure gradient. However, with respect to wall clouds surrounding the eye, radar photographs taken from the CPS-9 at Kadena AB show quite clearly, that on 20 August, the eye had a diameter of approximately 200 mi(see photograph this chapter). The eye diameter of CARMEN was probably one of the largest ever reported. When the center of the eye approached the S tip of Okinawa, fog occurred at Naha and Kadena from 201600Z to 202200Z.

For a brief discussion of the surface synoptic situation at the time CARMEN formed, see narrative, Typhoon BESS. While warnings were being issued on CARMEN, warnings were also being issued on Typhoons BESS, DELLA and ELAINE. Also, the final warning on T.S. AGNES was issued at the time the first warning was issued on CARMEN.

The final warning on CARMEN was issued at 240000Z, when the storm was near 50N. CARMEN traveled a distance of 1,900 mi in 8 days, an average of 240 mi a day or a speed of 10 kts. During the first 5 days it traveled only 360 mi, but on the last day, it traveled 840 mi.


2010
"CARMEN"
200MI SWEEP
20 AUG '60
Z TIME
KADENA


24/00Z POSIT 49.4N-134.7E
23/00Z
22/00Z
21/00Z
BEST TRACK
TYPHOON CARMEN
16-24 AUG 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
NOTE: FOR TRACK PRIOR TO 20/1200Z SEE FOLLOWING PAGE


MIYAKOJIMA
18/00Z
25°N
24°N
23°N
126°E
127°E
128°E
129°E
130°E
16/00Z
17/00Z
19/00Z
20/00Z
70
75
65
60
45
40
35
30
1
2
3
4
5
7Δ
8Δ
9Δ
5Δ
6Δ
BEST TRACK
TYPHOON CARMEN
BLOWUP
16/0000Z TO 20/1200Z AUG 1960

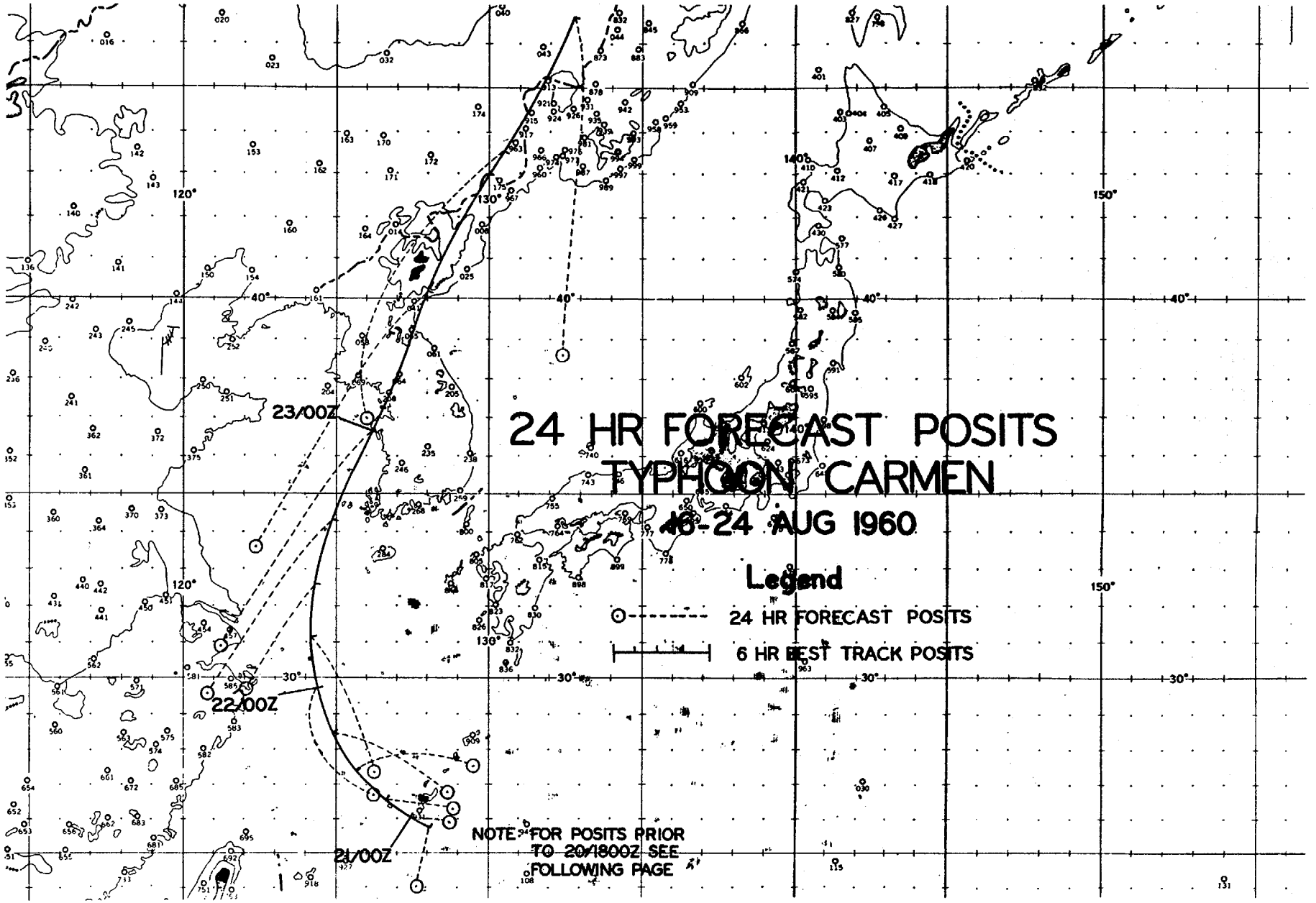
RECONNAISSANCE AIRCRAFT FIXES - TYPHOON CARMEN

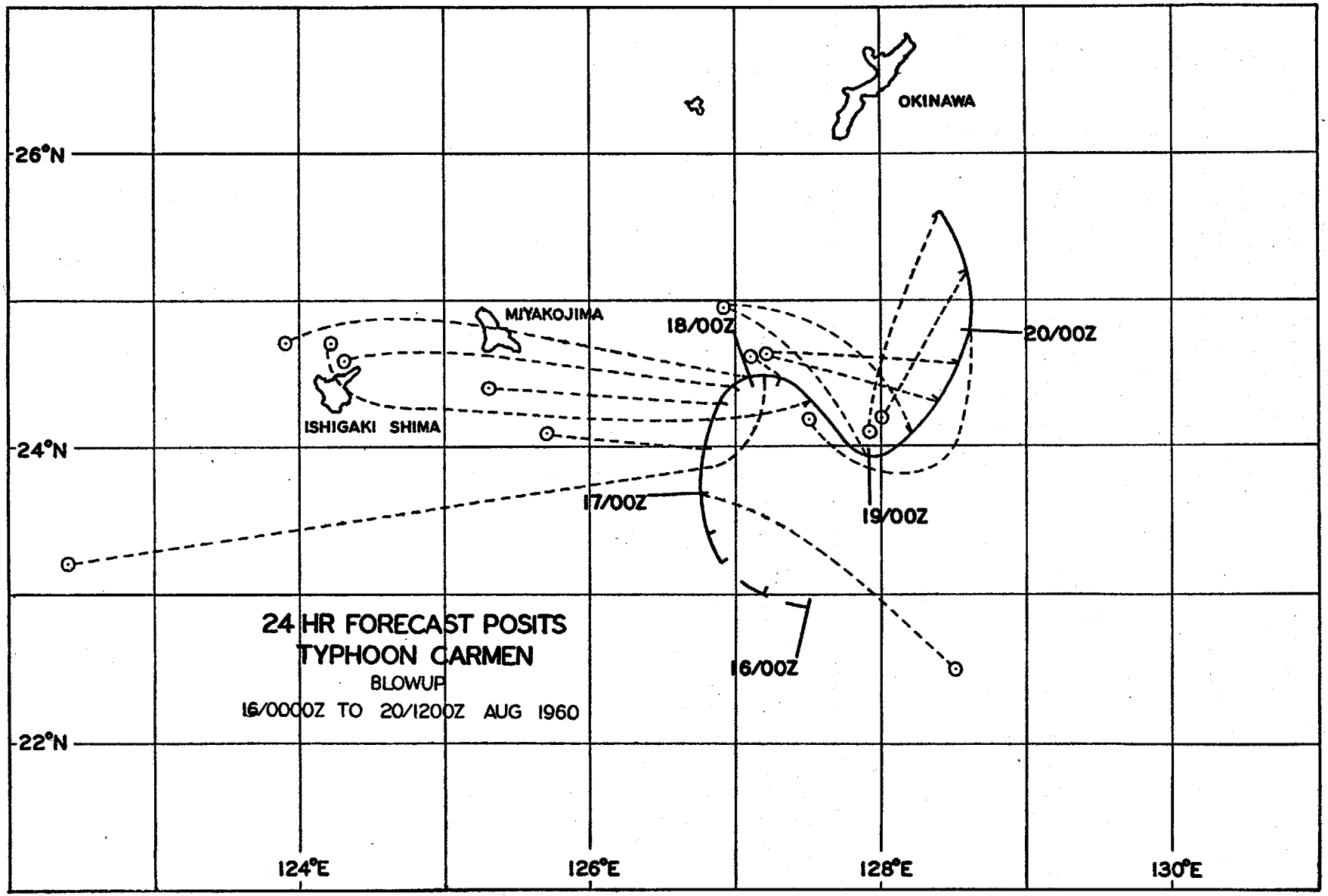
FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	170800Z	24.5N	127.1E	315-P-20	- -	60	9740 987	60	14/--	EYE ILL-DEFINED
2	180000Z	24.5N	127.1E	315-P-02	- -	70	9650 983	45	16/--	ELLIP N/S 130X80 WALL CLD W
3	180800Z	24.5N	127.2E	56-P---	- -	75	9590 981	- -	18/--	ELLIP N/S 100X60
4	182215Z	23.9N	127.8E	56-P-03	970	50	9590 981	60	18/--	CIRC DIA 100 MI
5	190330Z	24.2N	128.0E	56-P-03	972	60	9540 980	50	18/12	CIRC DIA 100 MI
6	190830Z	24.1N	127.9E	315-P-05	- -	65	9420 975	- -	18/--	CIRC DIA 100 MI
7	200030Z	24.8N	127.9E	315-P-10	- -	65	9490	- -	18/--	EYE OPEN 100 MI DIA
8	200300Z	25.0N	128.6E	56-T-10	- -	55	- - -	60	- - -	CENTER NOT DEFINED
9	201035Z	25.6N	128.6E	56-P-02	978	60	9630	40	15/13	CIRC DIA 100MI WALL CLD NE & E
10	202200Z	25.3N	127.5E	315-P-02	- -	50	9600	- -	18/--	- - - - - - - - - - - - - - - -
11	210400Z	26.3N	127.1E	56-P-02	980	50	9710	50	15/13	CIRC DIA 80 MI
12	210906Z	26.9N	126.2E	56-P-02	980	60	9650	80	15/14	HORSE SHOE SHAPE 70X50 MI
13	220141Z	29.3N	124.5E	56-P-04	975	45	9700	36	15/--	UNABLE TO DETERMINE

TYPHOON CARMEN 16-24 AUGUST 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
160000Z	22.9N	127.5E	- - - -	- - - -
160600Z	23.0N	127.2E	- - - -	- - - -
161200Z	23.2N	126.9E	- - - -	- - - -
161800Z	23.4N	126.8E	- - - -	- - - -
170000Z	23.7N	126.8E	- - - -	- - - -
170600Z	24.0N	126.8E	- - - -	- - - -
171200Z	24.3N	126.9E	- - - -	- - - -
171800Z	24.4N	127.0E	274-163	- - - -
180000Z	24.5N	127.1E	274-191	- - - -
180600Z	24.5N	127.2E	255-297	- - - -
181200Z	24.5N	127.3E	275-11	- - - -
181800Z	24.3N	127.5E	278-202	280-293
190000Z	23.9N	127.9E	313-84	284-342
190600Z	24.1N	128.2E	303-95	262-537
191200Z	24.3N	128.4E	281-74	278-70
191800Z	24.6N	128.5E	269-79	276-399
200000Z	24.8N	128.6E	240-76	306-167
200600Z	25.2N	128.6E	213-67	298-152
201200Z	25.6N	128.4E	202-93	230-97
201800Z	25.8N	128.1E	190-113	212-95
210000Z	26.1N	127.5E	100-78	180-110
210600Z	26.5N	126.7E	101-131	154-155
211200Z	27.4N	125.7E	088-204	149-224
211800Z	28.5N	124.9E	117-230	150-309
220000Z	29.8N	124.3E	157-260	123-312
220600Z	31.2N	124.1E	157-256	131-364
221200Z	32.6N	124.2E	210-229	122-376
221800Z	34.3N	124.9E	216-293	153-503
230000Z	36.7N	126.1E	- - - -	- - - -
230600Z	40.1N	128.0E	- - - -	- - - -
231200Z	43.6N	130.5E	- - - -	- - - -
231800Z	46.6N	132.9E	- - - -	- - - -
240000Z	49.4N	134.7E	- - - -	- - - -

AVERAGE 24 HOUR ERROR 154 MI
AVERAGE 48 HOUR ERROR 265 MI


24 HR FORECAST POSITS
TYPHOON CARMEN
16-24 AUG 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
23/00Z
22/00Z
21/00Z
NOTE: FOR POSITS PRIOR TO 20/1800Z SEE FOLLOWING PAGE
120°
130°
140°
150°
40°
30°



24 HR FORECAST POSITS
TYPHOON CARMEN
BLOWUP
16/0000Z TO 20/1200Z AUG 1960

M. TYPHOON DELLA (170900Z-310000Z AUGUST 1960)

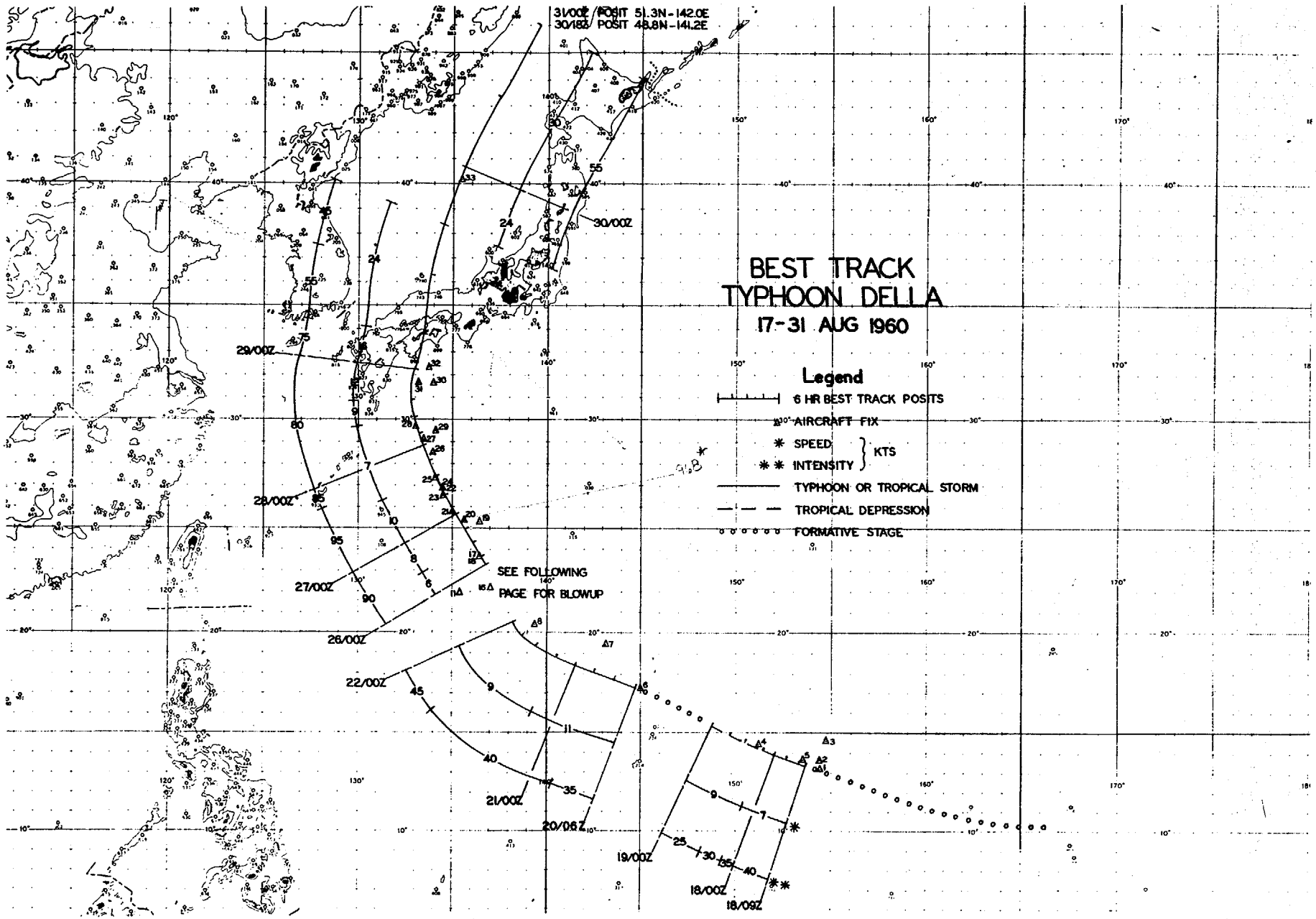
The first indication of Typhoon DELLA was a weak cyclonic circulation, between Kwajalein and Eniwetok, on the 120000Z surface chart. The circulation had moved quite close to Eniwetok by 140600Z, and by 170600Z it appeared to be embedded in the strong trough SE of T.S. BESS. A brief description of the general features of the 161200Z surface chart is contained in the narrative of Typhoon BESS.

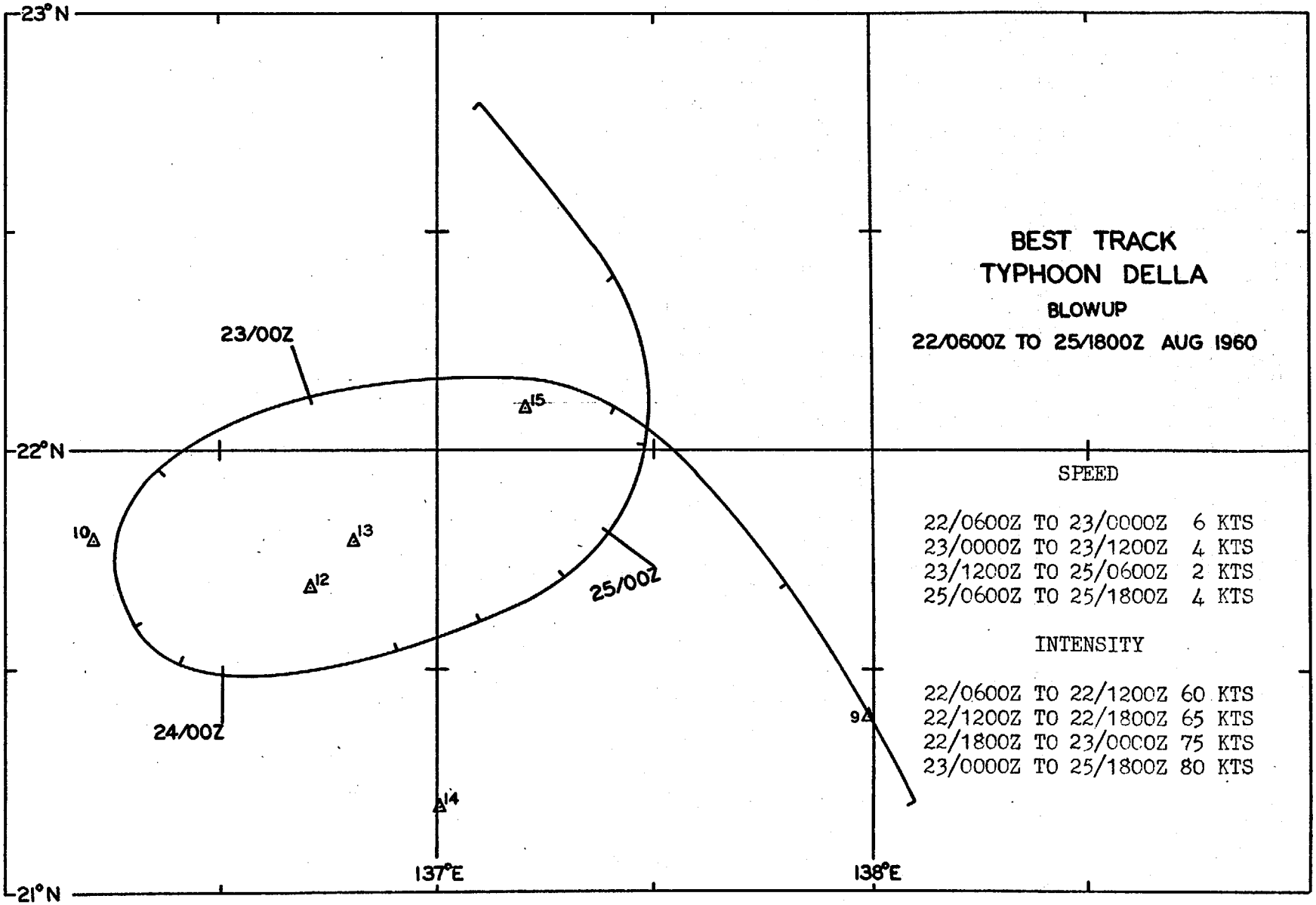
The initial warning (as a tropical storm) was issued at 170900Z, and it appeared that DELLA would intensify to full typhoon strength. However, subsequent reconnaissance, on 18 August, indicated that DELLA was no longer a closed circulation, and a final warning was issued at 190000Z. An investigation by an aircraft of VW-1 on 20 August disclosed that DELLA had regenerated, and the issuance of warnings, as a tropical storm, was resumed at 200600Z. DELLA moved on a track to the WNW at 11 kts, becoming a typhoon at 221200Z. Shortly after reaching typhoon intensity, DELLA, moving in a counterclockwise direction, followed a path which gradually described an ellipse. The ellipse was centered near 22N 137E, and the major axis was oriented ENE. DELLA moved along the 175 mi circumference of the ellipse at an initial speed of 6 kts, slowly decelerating to 2 kts. After completing the ellipse, DELLA moved to the NNW and then to the N, gradually accelerating to 16 kts at 290500Z, when it reached the Japanese island of Shikoku. At that time, the maximum winds had decreased from 95 to 75 kts, and passage over the island of Honshu further reduced the maximum wind speed to 45 kts. Miho (743), a city on the N coast of Honshu, was less than 20 mi W of DELLA's position between 291000Z and 291100Z, and reported maximum sustained winds of only 18 kts with gusts to 27 kts. DELLA accelerated to 30 kts after entering the Sea of Japan where the maximum winds, associated with the storm, reached only 55 kts. The final warning was issued at 310000Z, at which time DELLA was in the Gulf of Tatary, just E of Sakhalin Island.

DELLA traveled 3150 mi during the 13 days and 15 hours (first to last warning) that warnings were issued. The average speed of this system was 10 kts or 233 mi a day; the minimum speed was 2 kts while moving along the elliptical track, and the maximum speed was 30 kts during the last day of warnings. During the life of DELLA, warnings were also issued on Typhoons BESS, CARMEN, ELAINE, FAYE, and T.S. GLORIA.

Two unusual features marked DELLA as different: The elliptical track, roughly half way between Guam and Okinawa,

on 22, 23 and 24 August, and a double eye reported at 280914Z, the position of which was 29.7N 133.0E. The inner eye was oval shaped, 10 by 3 mi, and was oriented such that the longer axis was NE. The outer eye was 50 mi in diameter.


31/00Z POSIT 51.3N-142.0E
30/18Z POSIT 48.8N-141.2E
BEST TRACK
TYPHOON DELLA
17-31 AUG 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
SEE FOLLOWING PAGE FOR BLOWUP
30/00Z
29/00Z
28/00Z
27/00Z
26/00Z
22/00Z
21/00Z
20/06Z
19/00Z
18/00Z
18/09Z


23°N
22°N
21°N
137°E
138°E
23/00Z
24/00Z
25/00Z
10
12
13
14
15
9
BEST TRACK
TYPHOON DELLA
BLOWUP
22/0600Z TO 25/1800Z AUG 1960
SPEED
22/0600Z TO 23/0000Z 6 KTS
23/0000Z TO 23/1200Z 4 KTS
23/1200Z TO 25/0600Z 2 KTS
25/0600Z TO 25/1800Z 4 KTS
INTENSITY
22/0600Z TO 22/1200Z 60 KTS
22/1200Z TO 22/1800Z 65 KTS
22/1800Z TO 23/0000Z 75 KTS
23/0000Z TO 25/1800Z 80 KTS

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON DELLA

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	170430Z	13.2N	154.3E	VW1-P-10	- -	45	- - -	- -	- - -	30 KT SFC WND 40 MI RAD.
2	172200Z	13.6N	154.4E	56-P-10	- -	40	- - -	- -	- - -	EYE ILL-DEFINED
3	180300Z	14.7N	154.8E	USAF----	- -	- -	- - -	- -	- - -	- - - - - - - - - - - - - - -
4	180728Z	14.3N	151.1E	VW1-P-10	- -	35	- - -	- -	- - -	CIRC DIA 42 MI
5	180830Z	13.7N	153.6E	56-P-05	1012	- -	10210 1003	30	09/09	UNDEFINED 25 MI DIA
6	200440Z	17.2N	145.0E	VW1-P-10	- -	38	- - -	- -	- - -	CIRC DIA 35 MI
7	202100Z	19.4N	143.1E	56-P----	- -	- -	- - -	- -	- - -	INDEF CLOSED CIR
8	212200Z	20.3N	139.3E	56-P-10	1000	40	10080 998	40	13/10	DEFINED ONLY BY SPIRAL SC
9	220820Z	21.4N	138.0E	56-P-05	994	60	9920 993	50	14/09	ILL-DEFINED
10	230920Z	21.8N	136.2E	56-P-05	972	75	9530 979	60	17/14	CIRC DIA 15 MI WALL CLD NE-NW
11	232348Z	22.0N	135.3E	315-P-04	- -	85	9680 984	80	15/--	CIRC DIA 40 MI
12	240315Z	21.7N	136.7E	56-P-05	962	55	9460 976	55	15/--	EYE NOT DEFINED
13	240830Z	21.8N	136.8E	56-P-05	966	75	9430 975	78	16/10	ELLIP NE/SSW 30X45
14	242320Z	21.2N	137.0E	315-P-10	- -	70	9260 969	55	- - -	WALL CLD N QUAD ONLY
15	250745Z	22.1N	137.2E	56-P-25	969	65	9360 973	- -	- - -	ELLIP NW/SE 40X20
16	252140Z	23.1N	137.0E	56-P-05	966	75	9360 973	80	14/12	IRREGULAR 30 MI DIA
17	260300Z	23.7N	136.4E	56-P-10	970	100	9330	- -	14/12	ELLIP N/S 50X30
18	260800Z	23.7N	136.3E	56-P-03	918	85	9320	75	15/11	EYE FILLED WITH CLDS

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON DELLA (CONT'D)

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
19	261600Z	25.2N	136.3E	VW1-R-05	- -	- -	- - -	- -	- - -	19X4 ORIENTED 325° OPEN SE
20	262135Z	25.4N	135.7E	56-P-10	976	60	9210 968	- -	13/13	EYE VERY DIFFUSED
21	270230Z	25.8N	135.0E	56-P-15	980	85	9210 968	78	14/12	EYE 75% FILLED WITH CLDS
22	270800Z	26.9N	134.6E	56-P-05	970	95	9290	70	14/09	EYE NOT WELL DEFINED
23	270630Z	26.6N	134.8E	VW1---01	- -	- -	- - -	- -	- - -	CIRC DIA 20 MI
24	270830Z	27.0N	134.7E	VW1---01	- -	- -	- - -	- -	- - -	- - - - - - - - - - - - - - -
25	271425Z	27.3N	134.1E	VW1-R-05	- -	- -	- - -	- -	- - -	CIRC DIA 50 MI
26	272330Z	28.4N	134.0E	56-P-06	970	80	9240	70	16/16	CIRC DIA 40 MI OPEN N
27	280330Z	29.1N	133.3E	56-P-15	968	80	9290	80	15/14	NO WALL CLDS ON RADAR
28	280914Z	29.7N	133.0E	56-P-05	970	75	9250	80	16/15	EYE DOUBLE & ELLIP
29	281315Z	29.5N	134.1E	VW1-R-20	- -	- -	- - -	- -	- - -	CIRC DIA 58 MI
30	282315Z	31.7N	134.0E	56-P-05	974	75	9580	85	17/17	ELLIP 10X25 MI
31	282355Z	31.8N	133.1E	56-P-02	971	75	9170	80	16/16	CIRC DIA 12 MI
32	290325Z	32.4N	133.8E	56-P-01	- -	90	9240	65	17/17	CIRC DIA 10 MI
33	292230Z	40.1N	135.3E	315-P-02	- -	50	9530	- -	18/--	EYE NOT DEFINED

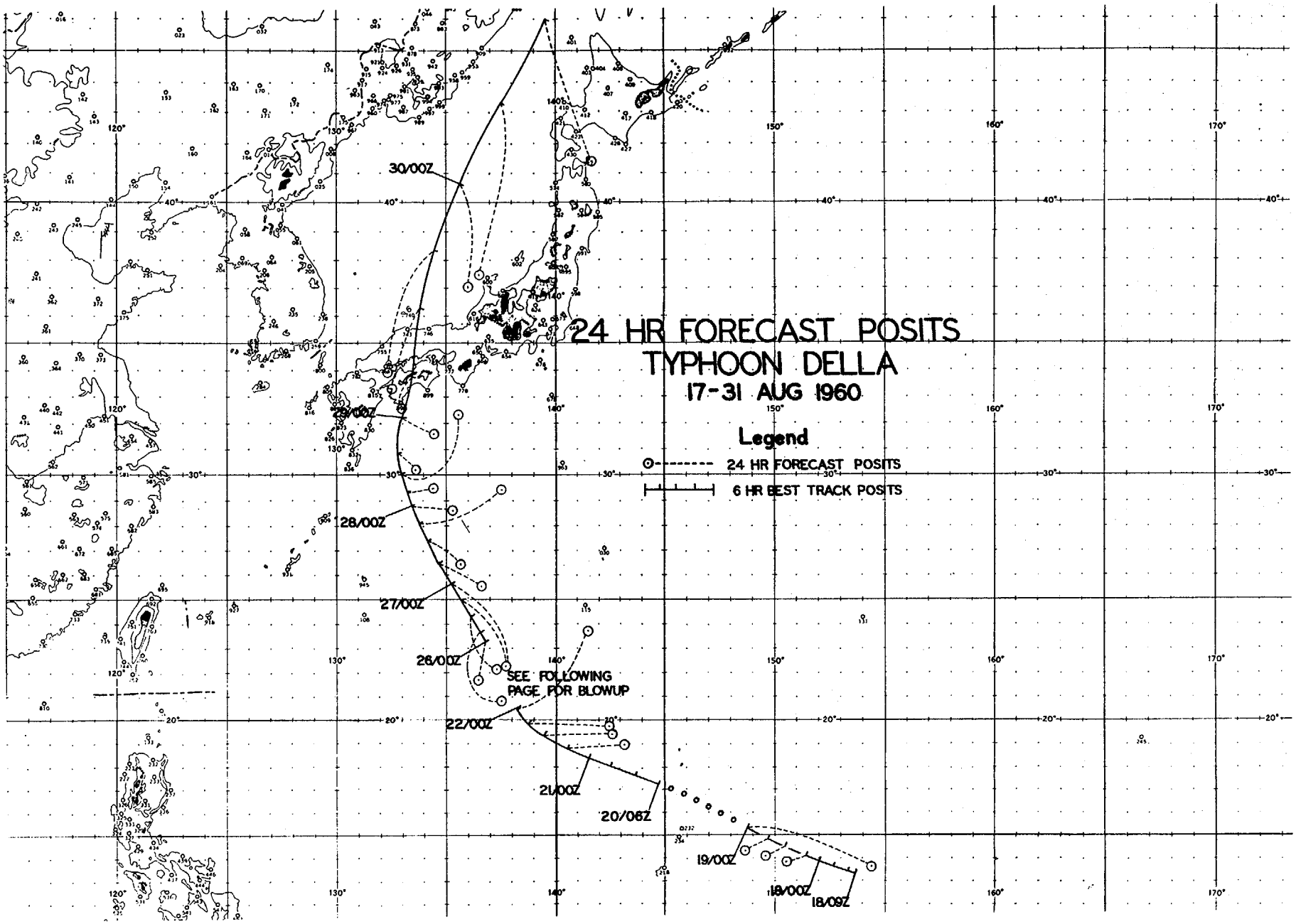
TYPHOON DELLA 17-31 AUGUST 1960
POSITION AND FORECAST VERIFICATION DATA

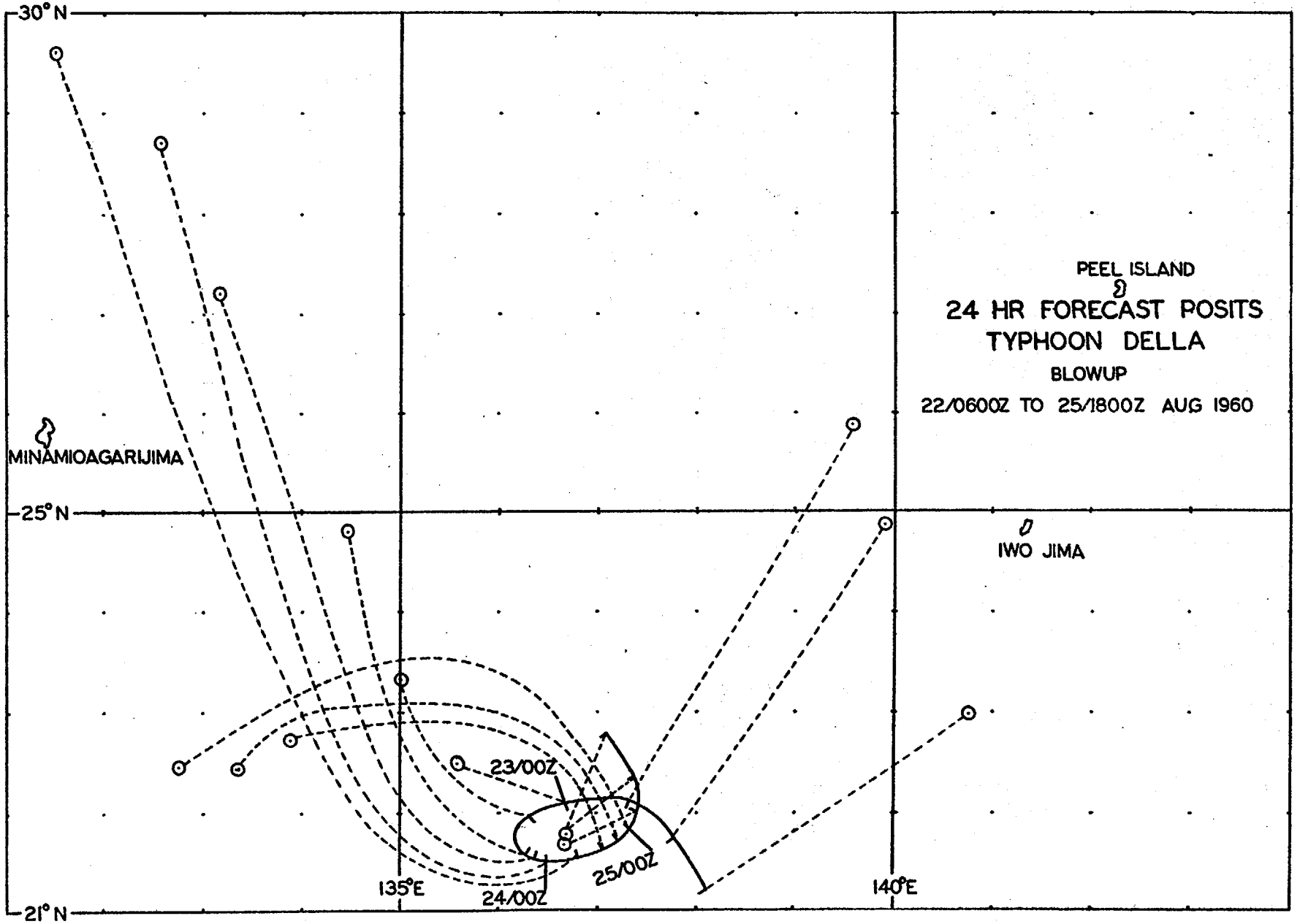
DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
170900Z	13.4N	153.8E	- - - -	- - - -
171200Z	13.5N	153.4E	- - - -	- - - -
171800Z	13.7N	152.7E	- - - -	- - - -
180000Z	14.0N	152.1E	- - - -	- - - -
180600Z	14.2N	151.3E	249-57	- - - -
181200Z	14.6N	150.5E	242-67	- - - -
181800Z	14.9N	149.7E	234-72	- - - -
190000Z	15.3N	148.9E	108-335	- - - -
190000Z TO 200600Z NO WARNINGS ISSUED				
200600Z	17.3N	144.8E	- - - -	- - - -
201200Z	17.7N	143.7E	- - - -	- - - -
201800Z	18.1N	142.6E	- - - -	- - - -
210000Z	18.4N	141.6E	- - - -	- - - -
210600Z	18.8N	140.5E	087-150	- - - -
211200Z	19.3N	139.4E	087-184	- - - -
211800Z	19.8N	138.7E	090-211	- - - -
220000Z	20.6N	138.2E	034-223	- - - -
220600Z	21.2N	138.1E	055-187	095-195
221200Z	21.7N	137.8E	031-218	095-193
221800Z	22.1N	137.4E	030-255	097-206
230000Z	22.1N	136.7E	290-66	022-384
230600Z	22.0N	136.3E	317-108	040-293
231200Z	21.6N	136.3E	321-168	024-400
231800Z	21.5N	136.4E	332-390	019-495
240000Z	21.5N	136.7E	333-486	307-340
240600Z	21.6N	136.9E	329-572	321-405
241200Z	21.6N	137.1E	292-180	331-528
241800Z	21.7N	137.3E	282-225	344-720
250000Z	21.8N	137.4E	279-262	341-819
250600Z	22.0N	137.5E	250-49	335-914
251200Z	22.4N	137.4E	248-48	281-313
251800Z	22.8N	137.1E	203-73	271-375
260000Z	23.2N	136.9E	188-90	267-345

TYPHOON DELIA 17-31 AUGUST 1960
POSITION AND FORECAST VERIFICATION DATA (CONT'D)

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
260600Z	23.7N	136.5E	161-181	174-122
261200Z	24.2N	136.1E	154-142	168-150
261800Z	24.9N	135.6E	145-203	163-195
270000Z	25.7N	135.2E	147-254	160-247
270600Z	26.6N	134.7E	119-122	153-395
271200Z	27.5N	134.3E	132-94	153-364
271800Z	28.1N	133.9E	066-200	150-417
280000Z	28.8N	133.6E	093-83	150-458
280600Z	29.4N	133.3E	088-55	095-190
281200Z	30.1N	133.0E	043-173	087-182
281800Z	30.9N	132.8E	140-66	079-402
290000Z	32.2N	133.0E	123-82	080-211
290600Z	33.8N	133.3E	190-81	100-201
291200Z	36.2N	133.5E	- - - -	- - - -
291800Z	38.4N	134.4E	- - - -	- - - -
300000Z	40.7N	135.7E	- - - -	- - - -
300600Z	43.3N	137.5E	- - - -	- - - -
301200Z	46.0N	139.5E	- - - -	- - - -
301800Z	48.8N	141.2E	- - - -	- - - -
310000Z	51.3N	142.0E	- - - -	- - - -

AVERAGE 24 HOUR ERROR 173 MI
AVERAGE 48 HOUR ERROR 361 MI


24 HR FORECAST POSITS
TYPHOON DELLA
17-31 AUG 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
30/00Z
29/00Z
28/00Z
27/00Z
26/00Z
SEE FOLLOWING PAGE FOR BLOWUP
22/00Z
21/00Z
20/06Z
19/00Z
18/00Z
18/09Z


30° N
25° N
21° N
135° E
140° E
MINAMIOAGARIJIMA
PEEL ISLAND
IWO JIMA
24 HR FORECAST POSITS
TYPHOON DELLA
BLOWUP
22/0600Z TO 25/1800Z AUG 1960
23/00Z
24/00Z
25/00Z

120

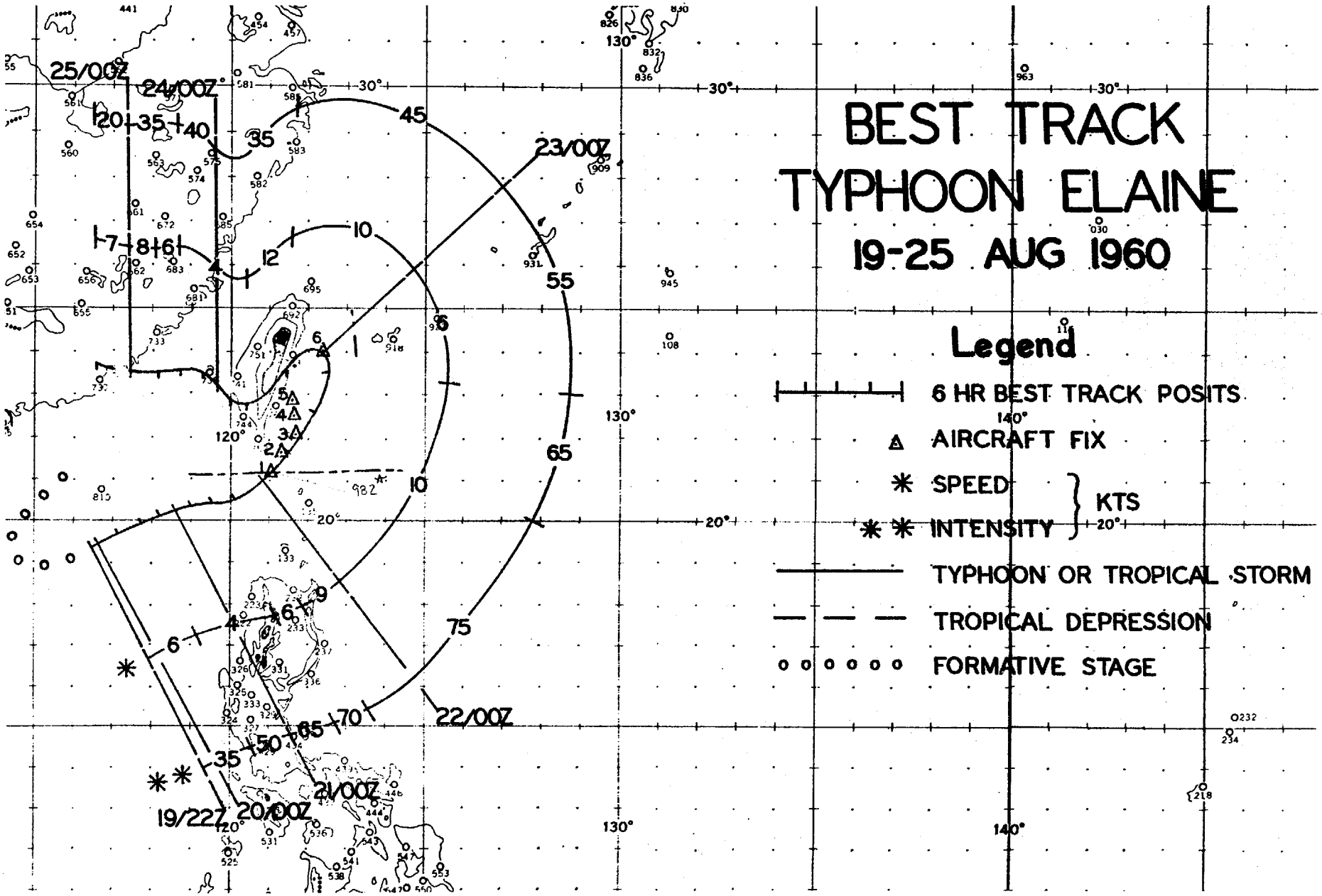
N. TYPHOON ELAINE (192200Z-250600Z AUGUST 1960)

At 200000Z, 2 hours after the first warning was issued on T.D. 13, later to become Typhoon ELAINE, the surface chart indicated that the trough (161200Z chart discussed in BESS narrative) had become oriented NE, from W of 18N 100E to 34N 143E. An average of the isobars through this trough equalled 995 mb. This represented an area of more than 1,000,000 square mi of poor weather, for embedded in it were Typhoons BESS and CARMEN as well as T.D. 13. At the time of the first warning the tropical depression, located 210 mi SE of Hong Kong, was moving ENE at 6 kts along the trough. A tropical storm warning was issued at 201200Z and ELAINE was classified as a typhoon at 211800Z, 110 mi W of Batan Island, although post analysis indicates that ELAINE was of tropical storm intensity at the time of the first warning and of typhoon intensity at 210600Z. ELAINE then moved NE to NNE, roughly parallel to and about 50 mi off the E coast of Taiwan to 24N before reversing direction. The typhoon was downgraded to a tropical storm at 221800Z, and by 230600Z had reversed direction and moved onto Taiwan. ELAINE "jumped" across the island between 230600Z and 231400Z. The speed of ELAINE was 10 kts when it touched land, 12 kts over land and then 4 kts after moving over the water area of Taiwan Strait. The storm moved WNW after departing Taiwan, passing the coastline of the Asiatic mainland at 250000Z. The final warning was issued at 250600Z.

It appears that ELAINE was "steered" by the circulation associated with Typhoon CARMEN until 221800Z, and then by the circulation, above the 700 mb level, of the high over the Asiatic mainland. Windwise, ELAINE had a closed circulation through the 300 mb level for part of the period that it was a typhoon, but was never closed at the 200 mb level.

During its "warning life", ELAINE traveled 850 mi over a period of 5 days and 8 hours, at an average speed of 7 kts or 158 mi a day. The minimum speed was 4 kts on 20, 21, 23 and 24 August, and the maximum speed was 12 kts on 23 August. Warnings were also issued on Typhoons BESS, CARMEN, DELLA and FAYE during this period.

ELAINE's track was quite unusual, but very similar to that of a typhoon that occurred during 1924 between 31 July and 6 August. The 1924 typhoon track was extracted from "Tropical Cyclones in the Western Pacific and China Sea area, 1884 to 1953", published by the Royal Observatory, Hong Kong.


BEST TRACK
TYPHOON ELAINE
19-25 AUG 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
25/00Z
24/00Z
23/00Z
22/00Z
21/00Z
20/00Z
19/22Z
120°
130°
140°
20°
30°

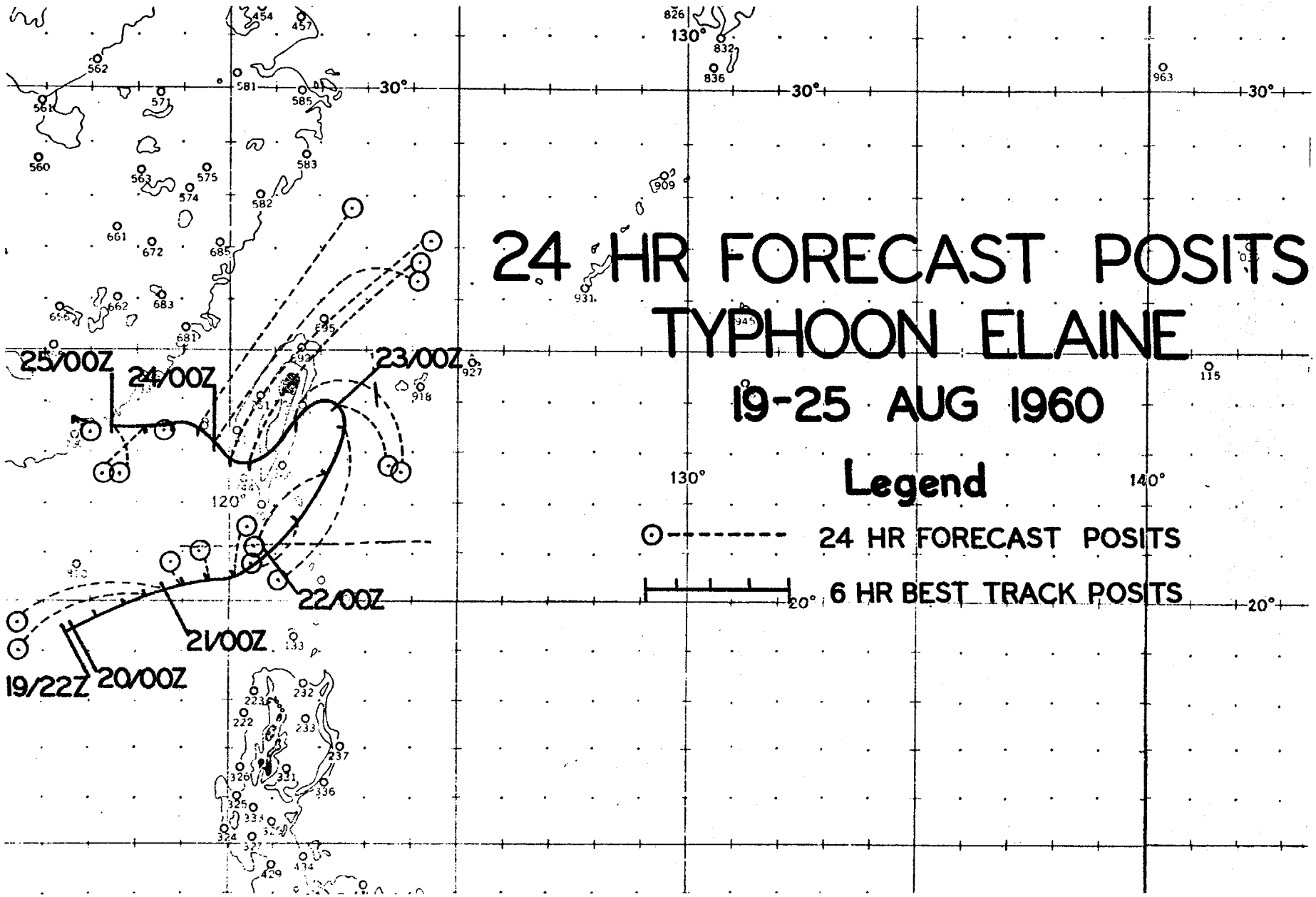
RECONNAISSANCE AIRCRAFT FIXES - TYPHOON ELAINE

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	220130Z	21.2N	121.0E	315-P-05	- -	60	9610 (982)	- -	17/--	ILL DEFINED, OPEN N & NE
2	220515Z	21.7N	121.3E	56-P-02	976	- -	9700 (985)	50	15/--	ORIEN NE-SW
3	220820Z	22.1N	121.7E	56-P-02	988	80	9690 (984)	60	15/--	ORIEN NE-SW
4	221531Z	22.6N	121.6E	VW1-R-05	- -	- -	- - -	- -	- - -	CIRC DIA 10MI ILL DEFINED
5	221653Z	22.9N	121.5E	VW1-R-10	- -	- -	- - -	- -	- - -	CIRC DIA 06MI ILL DEFINED
6	230100Z	24.0N	122.3E	56-P-01	994	45	9980 (995)	39	17/--	POORLY DEFINED OPEN SE-N

TYPHOON ELAINE 19-25 AUGUST 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
192200Z	19.3N	116.5E	- - - -		- - - -	
200000Z	19.4N	116.6E	- - - -		- - - -	
200600Z	19.7N	117.2E	- - - -		- - - -	
201200Z	19.9N	117.8E	- - - -		- - - -	
201800Z	20.1N	118.1E	- - - -		- - - -	
210000Z	20.2N	118.6E	- - - -		- - - -	
210600Z	20.3N	119.0E	- - - -		- - - -	
211200Z	20.3N	119.5E	340	44	- - - -	
211800Z	20.4N	120.1E	015	75	- - - -	
220000Z	21.0N	120.9E	262	33	- - - -	
220600Z	21.7N	121.5E	229	91	- - - -	
221200Z	22.6N	122.1E	222	132	238	94
221800Z	23.5N	122.5E	206	203	192	53
230000Z	24.0N	122.4E	139	98	198	160
230600Z	23.5N	121.4E	112	138	180	146
231200Z	22.8N	120.3E	041	316	138	110
231800Z	22.9N	120.0E	044	352	135	180
240000Z	23.2N	119.6E	052	308	076	388
240600Z	23.4N	119.2E	030	380	080	384
241200Z	23.5N	118.8E	233	15	033	633
241800Z	23.5N	118.1E	222	82	041	604
250000Z	23.5N	117.2E	175	64	052	566
250600Z	23.8N	116.5E	130	38	037	562

AVERAGE 24 HOUR ERROR 148 MI
AVERAGE 48 HOUR ERROR 323 MI


24 HR FORECAST POSITS
TYPHOON ELAINE
19-25 AUG 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
25/00Z
24/00Z
23/00Z
22/00Z
21/00Z
20/00Z
19/22Z
30°
130°
140°
120°
20°

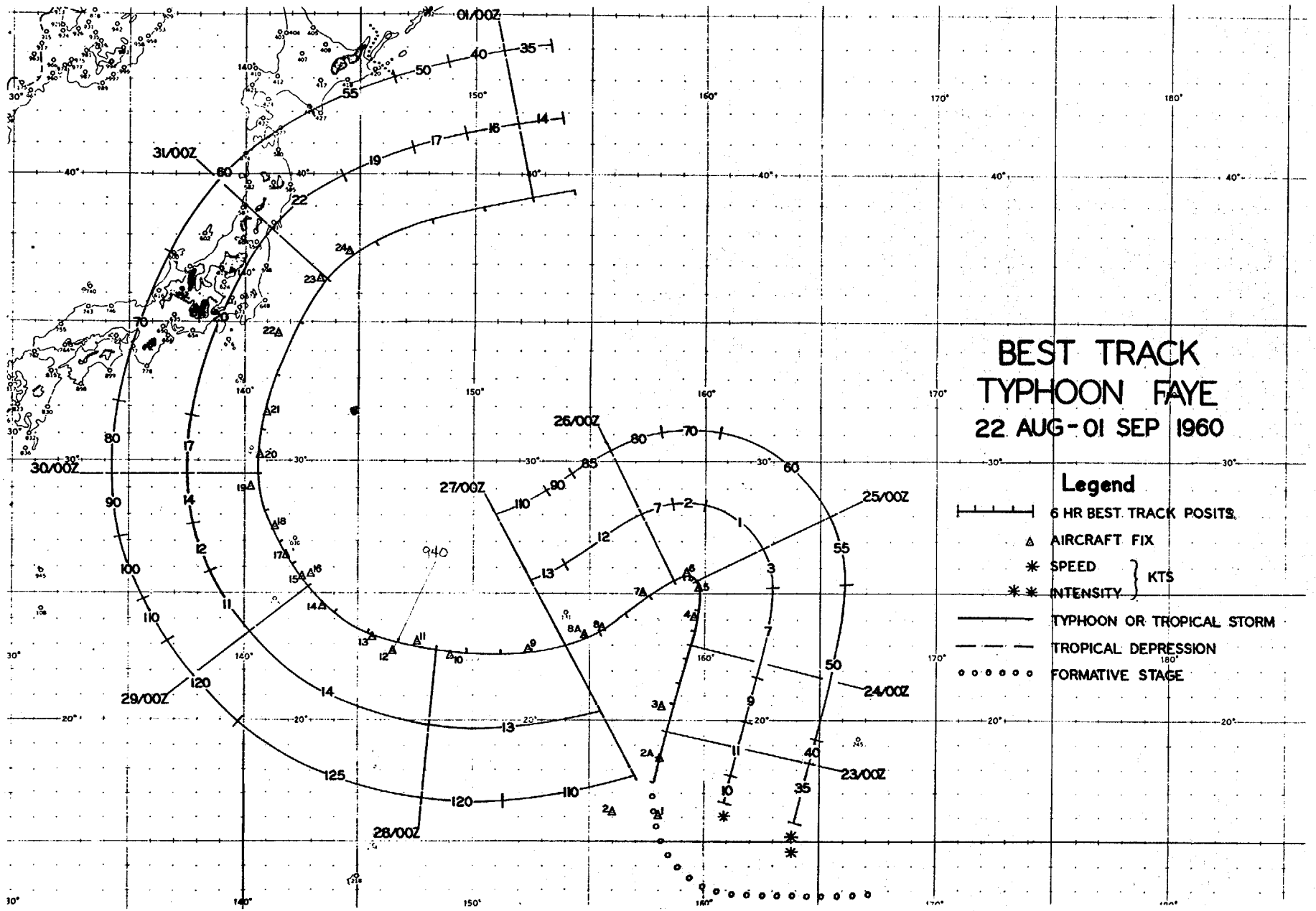
O. TYPHOON FAYE (221200Z AUGUST-010600Z SEPTEMBER 1960)

At 220300Z an aircraft, enroute from Guam to Wake, found what was estimated to be a tropical cyclone of storm intensity at 16.0N 158.0E. This information was not received by JTWC until some 4 or 5 hours later. Other than a weak circulation analyzed on the surface charts, this was our first indication of FAYE. As a result of the report, the initial warning, as a tropical storm, was issued on FAYE at 221200Z.

The storm moved N at 9 kts for the first 54 hours, steered by the elongated western portion of a high at 300 mb. During this period, warnings were being issued on four additional tropical disturbances (BESS, CARMEN, DELLA and ELAINE), greatly limiting the availability of reconnaissance aircraft to investigate FAYE. When FAYE reached 25N 160E, it became quasi-stationary and intensified to typhoon strength. It then began to move with the 200 mb flow, causing it to discontinue its movement to the N and to begin moving SW. The first typhoon warning was issued at 251800Z, although post-analysis indicates FAYE was of typhoon intensity at 251200Z. FAYE passed about 75 mi S of Marcus Island at 270000Z as it began to move W. However, the maximum sustained surface winds at Marcus were only 45 kts. At 280600Z a ship 150 mi SW of FAYE reported only 20 kt surface winds, while the reconnaissance fix reported maximum surface winds of 135 kts. This confirmed the fact that FAYE was a small but intense typhoon. An E-W elongated high at 200 mb, centered to the N of the typhoon, caused it to move W and then NW, and FAYE passed midway between Iwo Jima and Peel Island at approximately 290600Z. The maximum winds reported at Iwo Jima were 30 kts with gusts to 40 kts, and at Peel Island, 42 kts with gusts to 62 kts. It was here that FAYE commenced recurving N.

As FAYE recurved around the western edge of the anticyclone at 200 mb, it passed 35 mi to the WSW of Peel Island at 291100Z and 20 mi E of Tori Shima at 300330Z. The maximum surface winds at Tori Shima were 45 kts with a minimum sea level pressure of 991 mb. By 300000Z FAYE had begun to weaken, and 300 mbs appeared to become the dominant steering level, causing the storm to move NNE instead of N, thus eliminating any threat to Japan. FAYE was downgraded to a tropical storm at 310000Z, although post-analysis indicates FAYE weakened to tropical storm intensity at 301800Z. By 010000Z it was evident that the storm had weakened and filled, and the final tropical warning was issued at 010600Z, by which time FAYE had become extratropical.

A total of 40 warnings were issued, covering a period of 9 days and 18 hours. FAYE traveled 2800 mi and moved at an average speed of 12 kts or 286 mi per day during its "life". The range of its speed was from 1 to 22 kts.


BEST TRACK
TYPHOON FAYE
22 AUG - 01 SEP 1960
Legend
6 HR BEST TRACK POSITS.
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
01/00Z
31/00Z
30/00Z
29/00Z
28/00Z
27/00Z
26/00Z
25/00Z
24/00Z
23/00Z
940

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON FAYE

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	220300Z	16.0N	158.0E	USN-R---	- -	- -	- - -	- -	- - -	- - - - - - - - - - - - - -
2	221500Z	16.1N	156.0E	USN-----	- -	- -	- - -	- -	- - -	- - - - - - - - - - - - - -
2A	230115Z	18.5N	158.0E	USAF----	- -	- -	- - -	- -	- - -	- - - - - - - - - - - - - -
3	230612Z	21.5N	158.1E	VW1-P---	- -	50	- - -	- -	- - -	CIRC DIA 25 MI
4	241010Z	24.1N	159.4E	56---05	- -	- -	- - -	- -	- - -	- - - - - - - - - - - - - -
5	242000Z	25.3N	159.8E	56-P-10	994	45	9950	60	11/09	CIRC DIA 08 MI
6	252000Z	25.7N	159.2E	56-P-05	975	115	9720	60	14/10	CIRC DIA 20 MI
7	260640Z	25.0N	157.2E	56-P-05	968	65	9470	70	16/11	CIRC DIA 20 MI WALL CLDS SOLID
8	261820Z	23.8N	155.5E	PAN AM	- -	- -	- - -	- -	- - -	- - - - - - - - - - - - - -
8A	262015Z	23.3N	154.9E	56-P-01	960	120	9080	80	15/12	CIRC DIA 08 MI
9	270645Z	22.9N	152.3E	56-P-10	953	110	- - -	70	16/12	CIRC DIA 05 MI
10	272100Z	22.6N	149.0E	56-P-05	950	125	9020	90	15/10	CIRC DIA 12 MI WELL DEFINED WALL CLDS
11	280230Z	23.1N	147.6E	56-P-05	941	135	8760	100	16/11	CIRC DIA 17 MI
12	280730Z	22.8N	146.4E	56-P-05	940	- -	8570	85	17/12	CIRC DIA 30 MI
13	280945Z	23.3N	145.7E	VW1-R-10	- -	- -	- - -	- -	- - -	CIRC DIA 26 MI
14	282125Z	24.5N	143.4E	56-P-05	952	120	8920	80	14/11	CIRC DIA 12 MI
15	290230Z	25.6N	142.5E	56-P-02	948	120	8930	70	14/12	CIRC DIA 20 MI
16	290235Z	25.8N	143.0E	315-R-05	- -	- -	- - -	- -	- - -	CIRC DIA 25 MI
17	290800Z	26.4N	141.9E	56-P-01	962	120	8920	90	12/12	CIRC DIA 20 MI

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON FAYE (CONT'D)

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
18	291500Z	27.5N	141.3E	VW1-R-10	- -	- -	- - -	- -	- - -	CIRC DIA 26 MI
19	292205Z	29.0N	140.1E	56-P-08	968	100	9180	60	14/08	ELLIP NW 30X25 MI
20	300215Z	30.2N	140.8E	56-P-02	958	80	9240	60	18/11	ELLIP NW 35X25 MI
21	300825Z	31.8N	141.0E	56-P-05	979	- -	9590	75	17/12	HORSESHOE 20X70 MI OPEN N
22	301620Z	34.7N	141.5E	VW1-R-20	- -	- -	- - -	- -	- - -	CIRC DIA 25 MI
23	302330Z	36.5N	143.2E	56-P-05	1005	65	10030	40	12/12	50 MI DIA OPEN NW
24	310300Z	37.4N	144.6E	56-P-05	993	- -	9790	32	17/17	50 MI DIA OPEN NW

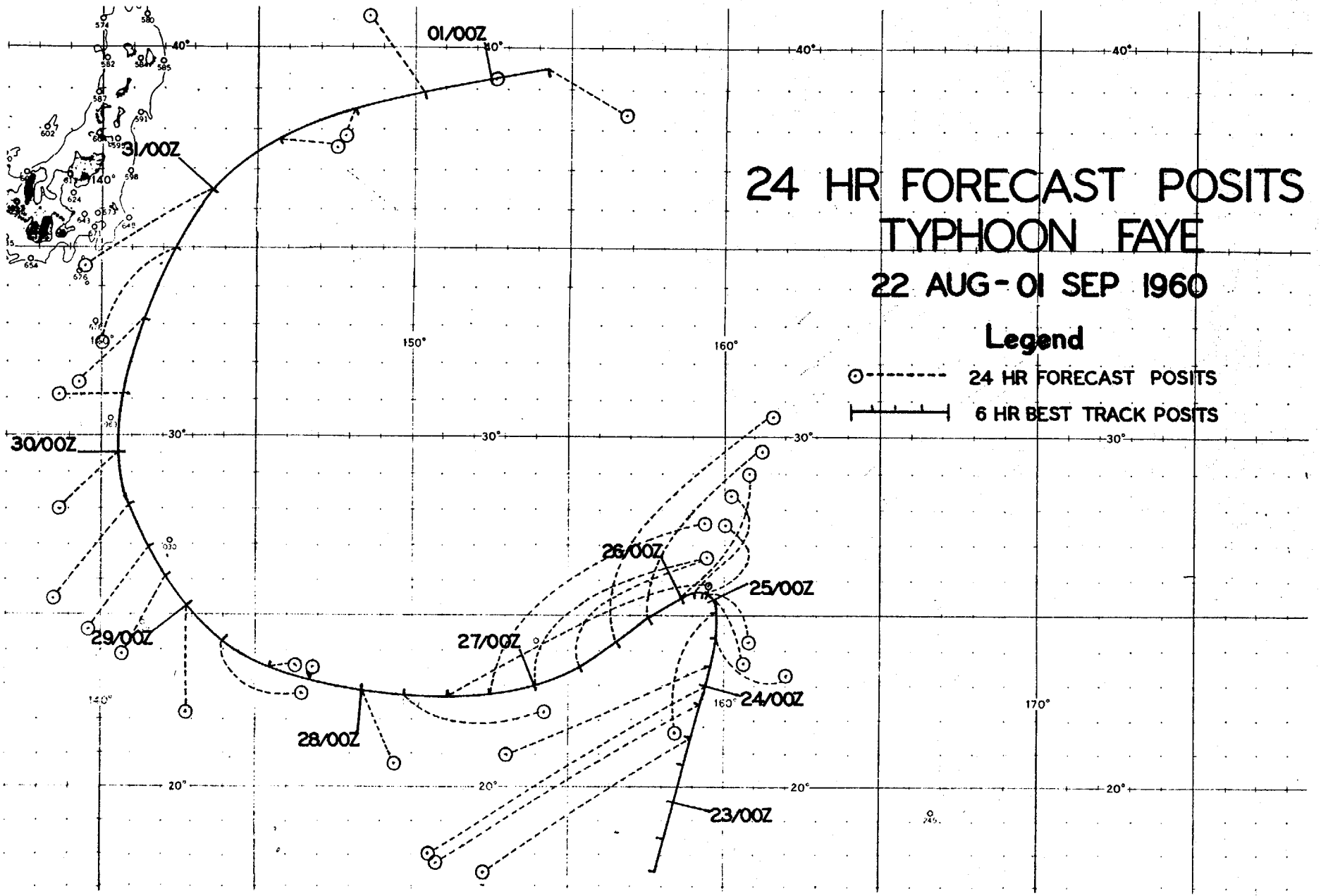
TYPHOON FAYE 22 AUGUST-01 SEPTEMBER 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
221200Z	17.5N	157.9E	- - - -	- - - -
221800Z	18.5N	158.0E	- - - -	- - - -
230000Z	19.5N	158.3E	- - - -	- - - -
230600Z	20.6N	158.7E	- - - -	- - - -
231200Z	21.4N	159.0E	237-450	- - - -
231800Z	22.3N	159.2E	242-550	- - - -
240000Z	23.0N	159.5E	239-588	- - - -
240600Z	23.6N	159.7E	247-401	- - - -
241200Z	24.4N	159.8E	120-137	244-736
241800Z	25.1N	159.8E	200-225	247-800
250000Z	25.4N	159.7E	155-111	245-795
250600Z	25.5N	159.6E	140-94	257-603
251200Z	25.6N	159.5E	009-130	110-313
251800Z	25.7N	159.4E	013-170	192-250
260000Z	25.6N	158.6E	030-229	095-165
260600Z	25.1N	157.4E	036-336	079-252
261200Z	24.3N	156.4E	037-457	030-440
261800Z	23.5N	155.3E	051-286	031-547
270000Z	23.0N	154.0E	053-366	041-687
270600Z	22.9N	152.5E	065-407	044-798
271200Z	22.8N	151.1E	070-485	048-913
271800Z	22.8N	149.8E	099-255	063-594
280000Z	22.9N	148.3E	153-138	065-665
280600Z	23.0N	146.8E	302-57	068-737
281200Z	23.5N	145.3E	080-52	081-775
281800Z	24.2N	144.0E	124-153	110-449
290000Z	25.2N	142.8E	180-185	146-260
290600Z	26.1N	142.1E	210-153	143-70
291200Z	27.0N	141.5E	216-175	143-175
291800Z	28.1N	140.9E	219-212	163-340
300000Z	29.5N	140.5E	229-133	196-467
300600Z	31.2N	140.8E	268-110	230-292
301200Z	33.1N	141.4E	228-160	223-458
301800Z	35.0N	142.3E	218-191	224-541

TYPHOON FAYE 22 AUGUST-01 SEPTEMBER 1960
POSITION AND FORECAST VERIFICATION DATA (CONT'D)

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
310000Z	36.6N	143.5E	- - - -		- - - -	
310600Z	37.9N	145.8E	- - - -		- - - -	
311200Z	38.5N	148.1E	- - - -		- - - -	
311800Z	38.8N	150.3E	- - - -		- - - -	
010000Z	39.2N	152.3E	- - - -		- - - -	
010600Z	39.5N	154.1E	- - - -		- - - -	

AVERAGE 24 HOUR ERROR 246 MI
AVERAGE 48 HOUR ERROR 505 MI


24 HR FORECAST POSITS
TYPHOON FAYE
22 AUG - 01 SEP 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
01/00Z
31/00Z
30/00Z
29/00Z
28/00Z
27/00Z
26/00Z
25/00Z
24/00Z
23/00Z
40°
30°
20°
140°
150°
160°
170°

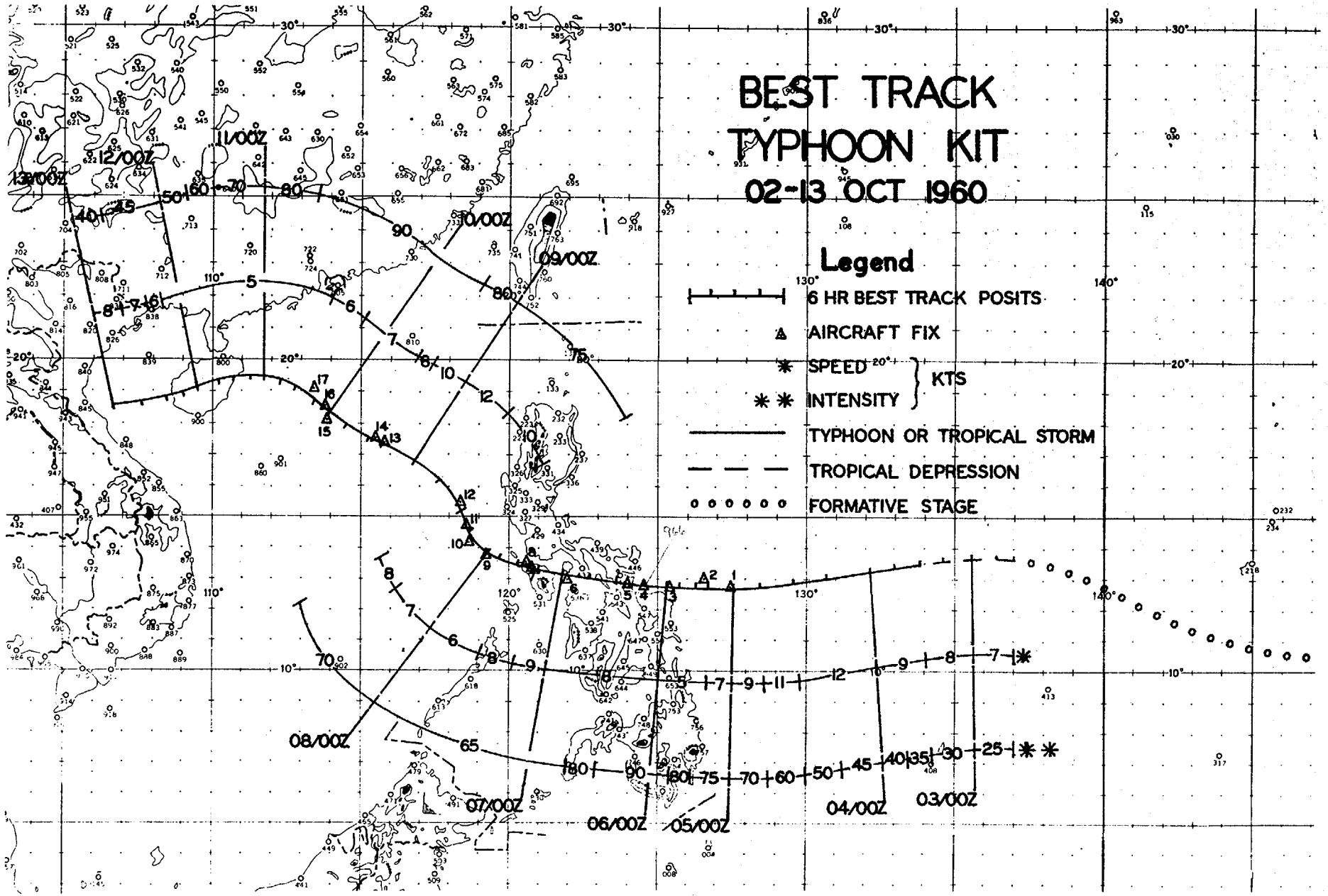
P. TYPHOON KIT (021200Z-130000Z OCTOBER 1960)

The birth of KIT as T.D. 20 was not a surprising event. The circulation had gradually increased in size over a period of several days to an immense cyclone, whose E-W length was more than 1500 mi, extending from the Philippines to E of Guam, and whose N-S length was more than 600 mi. The surface winds were no more than 25 kts, and the central pressure was no lower than 1001 mb at 021200Z, the time of the first warning. The cyclone grew smaller in area and more intense as it developed into a typhoon. Storm intensity winds were reached by 031200Z and KIT achieved typhoon strength by 041800Z. From the first warning KIT followed a course to the W moving 7 to 12 kts, roughly along 13N, passed between Samar and Catanduanes Islands and moved onto Legaspi Island, 200 mi SE of Manila at 060900Z. It became somewhat weaker while over land, but accelerated slightly. The typhoon entered the South China Sea at 071000Z and commenced intensifying again as it moved NW, finally achieving a speed of 12 kts. KIT was 200 mi SSW of Hong Kong at 101200Z, at which time it began turning W again. The wind speeds about KIT steadily decreased from 90 kts at 101200Z to 60 kts at 111200Z, the same time that it passed the coast line of Hainan Island. The last warning was issued on T.S. KIT at 130000Z, 140 mi SSE of Hanoi, North Vietnam.

Typhoon KIT followed the track of climatology very well, and is one of the few of the season that did. Warnings were issued for 10 and one half days over a distance of 1900 mi. The cyclone traveled at the average rate of 7 to 8 kts or 181 mi per day. Circulationwise, Typhoon KIT appears to have extended through the 300 mb level, but did not extend to the 200 mb level as a closed circulation.

Warnings were also issued on Typhoon LOLA during the warning life of KIT.

There were no unusual features associated with Typhoon KIT.


BEST TRACK
TYPHOON KIT
02-13 OCT 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
11/00Z
12/00Z
13/00Z
10/00Z
09/00Z
08/00Z
07/00Z
06/00Z
05/00Z
04/00Z
03/00Z

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON KIT

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	042316Z	12.7N	127.5E	56-P-05	980	75	9910 992	60	15/09	35 MI DIA
2	050925Z	13.0N	126.6E	56-P-05	976	75	9940 993	58	14/08	CIRC DIA 08 MI
3	060030Z	12.8N	125.3E	56-P-02	972	80	9200 968	70	15/--	CIRC DIA 15 MI
4	060400Z	12.8N	124.6E	56-P-02	966	100	- - -	*60	*-3/-6	CIRC DIA 18 MI
5	060820Z	12.9N	124.0E	56-P-02	968	- -	- - -	*72	*-2/-2	POORLY DEFINED DIA 12 MI
6	062250Z	13.0N	122.0E	56-P-02	- -	- -	- - -	*80	*-2/-2	CIRC DIA 40 MI
7	070730Z	13.3N	120.8E	56-P-00	- -	- -	- - -	*55	*-4/--	CIRC
8	070920Z	13.4N	120.6E	56-P-00	- -	45	- - -	*50	*-2/--	CIRC WALL CLDS DIFFUSE
9	072255Z	13.8N	119.2E	56-P-05	992	35	9930	30	07/05	NO DEFINED EYE
10	080345Z	14.1N	118.7E	56-P-05	996	- -	9910 992	45	07/--	POORLY DEFINED EYE
11	080830Z	14.8N	118.6E	56-P-01	987	75	9980 995	50	10/08	CIRC DIA 40 MI OPEN N
12	081500Z	15.4N	118.3E	VP40-R--	- -	- -	- - -	- -	- - -	- - - - - - - - - - - - - - -
13	090440Z	17.4N	115.9E	56-P-05	976	85	9630 982	60	18/--	CIRC DIA 40 MI OPEN E-S
14	090900Z	17.5N	115.5E	56-P-05	978	75	9480 977	65	16/--	CIRC DIA 40 MI
15	092333Z	18.1N	113.9E	56-P-05	975	90	9380 974	85	15/07	OPEN ALL QUADS
16	100435Z	18.6N	113.9E	56-P-15	978	65	9520	70	14/10	CIRC DIA 60 MI
17	100800Z	19.1N	113.4E	56-P-10	970	80	9470 976	87	14/08	CIRC DIA 60 MI WALL CLDS ALL QUADS

* MAX 500 MB WND TEMP AND DEW PT

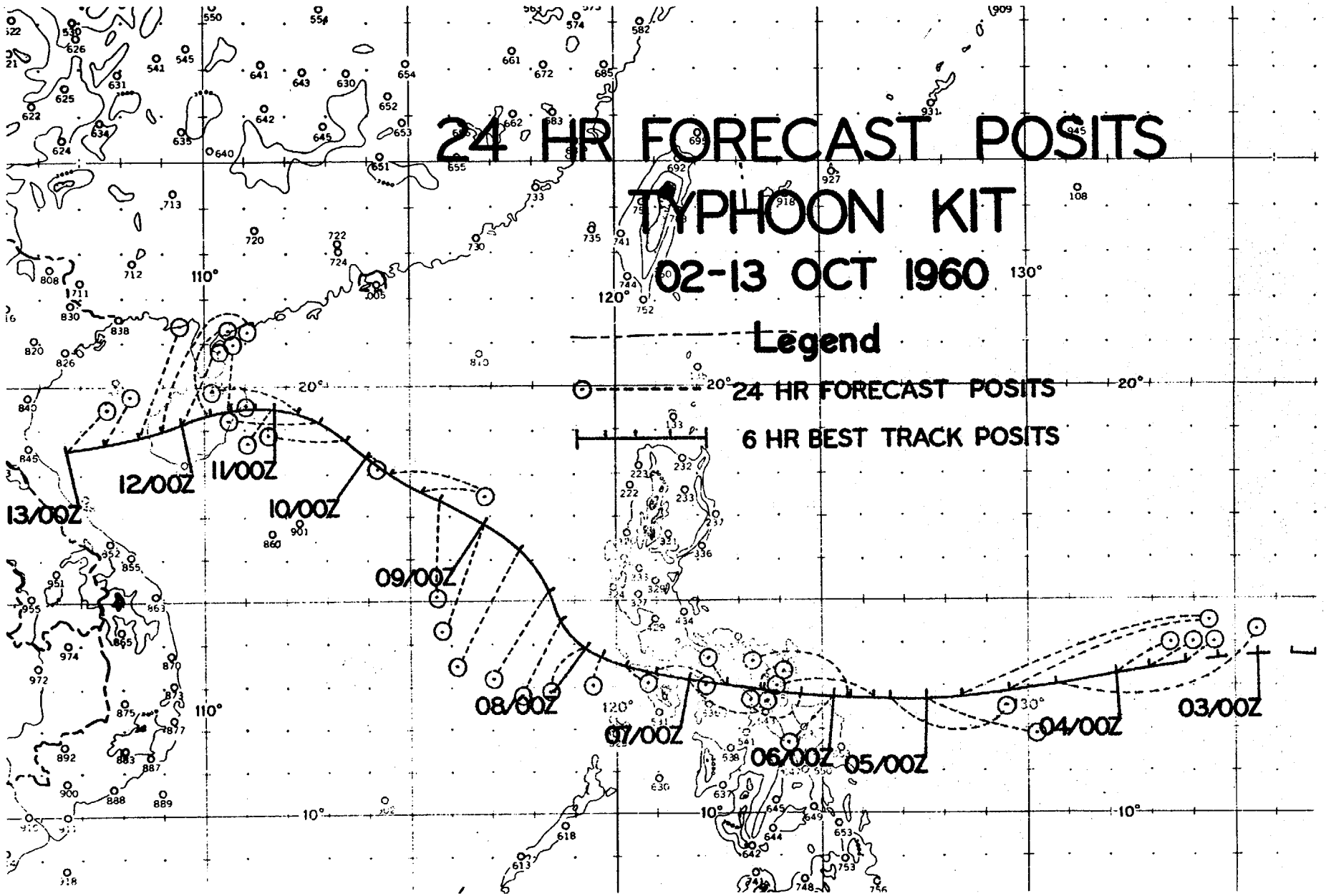
TYPHOON KIT 02-13 OCTOBER 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
021200Z	13.7N	137.0E	- - - -	- - - -
021800Z	13.8N	136.3E	- - - -	- - - -
030000Z	13.7N	135.6E	- - - -	- - - -
030600Z	13.6N	134.7E	- - - -	- - - -
031200Z	13.5N	133.9E	- - - -	- - - -
031800Z	13.3N	133.0E	- - - -	- - - -
040000Z	13.2N	132.1E	- - - -	- - - -
040600Z	13.1N	130.8E	- - - -	- - - -
041200Z	12.9N	129.6E	- - - -	- - - -
041800Z	12.8N	128.5E	- - - -	- - - -
050000Z	12.8N	127.6E	- - - -	- - - -
050600Z	12.8N	126.8E	102-152	- - - -
051200Z	12.8N	126.3E	274-154	- - - -
051800Z	12.8N	125.8E	285-155	- - - -
060000Z	12.8N	125.3E	264-70	- - - -
060600Z	12.8N	124.5E	263-73	087-147
061200Z	12.9N	123.7E	046-29	270-142
061800Z	13.0N	122.8E	321-53	285-120
070000Z	13.1N	121.9E	058-93	251-69
070600Z	13.2N	121.0E	100-65	246-71
071200Z	13.3N	120.2E	127-38	079-88
071800Z	13.6N	119.7E	209-40	278-91
080000Z	13.9N	119.2E	219-76	114-136
080600Z	14.5N	118.7E	209-112	151-110
081200Z	15.2N	118.4E	213-149	190-150
081800Z	16.1N	117.8E	213-184	212-248
090000Z	16.8N	116.9E	201-173	201-284
090600Z	17.3N	115.9E	187-137	195-309
091200Z	17.6N	115.2E	094-98	196-310
091800Z	18.0N	114.6E	102-142	205-297
100000Z	18.4N	114.0E	166-78	199-271
100600Z	18.8N	113.4E	273-99	196-204
101200Z	19.1N	112.9E	272-137	078-247
101800Z	19.3N	112.3E	286-125	095-148
110000Z	19.4N	111.8E	225-60	188-150

TYPHOON KIT 02-13 OCTOBER 1960
POSITION AND FORECAST VERIFICATION DATA (CONT'D)

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
110600Z	19.4N	111.2E	283-29	276-204
111200Z	19.4N	110.6E	360-98	274-214
111800Z	19.3N	110.1E	015-113	289-176
120000Z	19.1N	109.5E	023-116	258-36
120600Z	19.0N	109.0E	041-173	331-83
121200Z	18.9N	108.4E	035-100	003-117
121800Z	18.8N	107.6E	025-65	202-245
130000Z	18.7N	106.7E	049-64	200-195

AVERAGE 24 HOUR ERROR 102 MI
AVERAGE 48 HOUR ERROR 174 MI


24 HR FORECAST POSITS
TYPHOON KIT
02-13 OCT 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
12/00Z
11/00Z
10/00Z
09/00Z
08/00Z
07/00Z
06/00Z
05/00Z
04/00Z
03/00Z
13/00Z
110°
120°
130°
20°
10°
30°

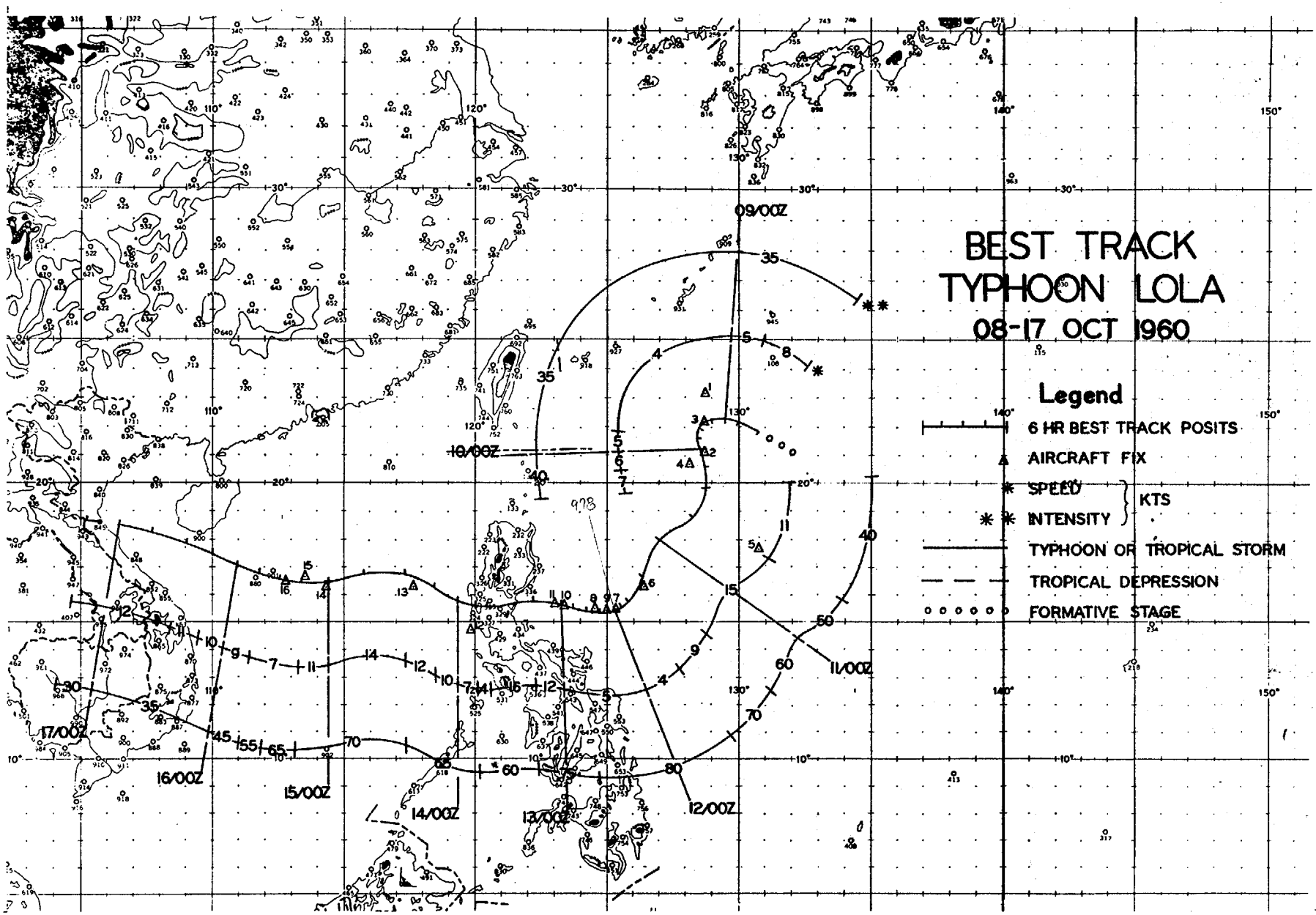
Q. TYPHOON LOLA (081200Z-170600Z OCTOBER 1960)

After Typhoon KIT moved over the South China Sea, a small circulation began to develop in the trough behind and about 700 mi NE of it, near 20N 130E. It was first noted at 080000Z, and by 081200Z the circulation was intense enough to be classified as T.S. LOLA.

LOLA initially moved toward Taiwan, but abruptly turned S during the 12 hours subsequent to 090600Z and accelerated from 4 to 15 kts. The storm was upgraded to a typhoon at 110600Z, about 340 mi ENE of Manila. Shortly thereafter, LOLA turned W, and it appeared to be headed toward Manila. The typhoon moved onto the coast of Luzon Island 80 mi NNE of Manila at 130800Z. LOLA passed about 20 mi N of Clark AB just before 131200Z. It appears that the typhoon circulation, within the lower few thousand feet, was weakened by the terrain, and after passing beyond Luzon Island over the South China Sea, reformed as a result of the sustained upper air circulation. This created the appearance of the typhoon "jumping" across the island of Luzon. The reader is referred to "The Problem of Typhoon Forecasting Over Taiwan and its Vicinity", by Lt. Colonel Hsu Ying-Chin, published in the Record of Proceedings, U.S.-Asian Military Weather Symposium, 9-12 February 1960, for further discussion of this phenomena. LOLA moved over the South China Sea after 131800Z and the surface winds intensified to 70 kts by 141200Z. The typhoon decreased to tropical storm intensity by 151200Z, and passed 20 mi S of Hainan Island at 161200Z, then onto the North Vietnam coastline, 20 mi SE of Vinh at 170300Z. The last warning was issued at 170600Z.

Thirty-six warnings were issued on LOLA during 8 days and 18 hours over a distance of 1800 mi. The tropical circulation moved at an average speed of 9 kts or 208 mi per day. The minimum speed of movement was 4 kts and the maximum was 15 kts. The typhoon extended through the 500 mb level as a closed circulation while in the vicinity of Clark AB, and certainly influenced the circulation through 35000 ft. Lack of data again precludes a more definitive measurement of intensity at higher levels.

LOLA moved toward Typhoon KIT throughout its life, except for the first 24 hours. This track appears to have been along the southern side of the upper air anticyclone that was over the Asiatic continent. Tracks from N to S seldom appear to the E of the Philippines, and for this reason the track may be considered the most unusual feature of Typhoon LOLA.


BEST TRACK
TYPHOON LOLA
08-17 OCT 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
09/00Z
10/00Z
11/00Z
12/00Z
13/00Z
14/00Z
15/00Z
16/00Z
17/00Z
908

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON LOLA

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	090300Z	23.1N	128.8E	VW1-P-05	1001	45	- - -	- -	- - -	CLEAR S AND W-NW QUADS
2	100115Z	21.1N	128.8E	56-P-05	- -	40	10090	30	13/09	CIRC DIA 50 MI OPEN W&NW
3	100300Z	22.2N	128.8E	USN-----	- -	- -	- - -	- -	- - -	- - - - - - - - - - - - - - -
4	100723Z	20.7N	128.1E	56-P-05	1006	15	10050	30	11/09	CIRC DIA 20 MI WALL CLDS ALL QUADS
5	102200Z	17.7N	130.7E	56-P-07	999	20	10110 (999)	35	12/--	EYE POORLY DEFINED
6	110800Z	16.2N	126.3E	56-P-05	1002	70	9760 (987)	55	18/11	CIRC DIA 10 MI OPEN E
7	120030Z	15.4N	125.2E	56-P-04	978	70	9600 (981)	55	22/15	CALM WNDS 30 MI DIA
8	120820Z	15.3N	124.6E	VW1-R---	- -	- -	- - -	- -	- - -	CIRC DIA 22 MI
9	121430Z	15.3N	125.0E	VW1-R-10	- -	- -	- - -	- -	- - -	POORLY DEFINED OPEN NW-NE
10	122300Z	15.7N	123.4E	56-P-04	986	45	9830 (979)	50	16/13	CIRC DIA 10 MI
11	130300Z	15.8N	123.0E	56-P-02	979	80	9890 (991)	35	18/13	CIRC DIA 10 MI OPEN NE
12	131530Z	14.8N	119.9E	VW1-R---	- -	- -	- - -	- -	- - -	WEAK CIRC AREA
13	140731Z	16.2N	117.7E	56-P-03	1000	65	9960 (995)	55	10/09	DIA 35 MI OPEN N
14	150030Z	16.2N	114.2E	56-P-10	990	60	9990 (996)	30	11/08	POORLY DEFINED OPEN W-N
15	150400Z	16.7N	113.5E	56-P-10	996	75	9930	35	09/08	CIRC DIA 25 MI OPEN N
16	150908Z	16.4N	112.9E	56-P-04	- -	- -	9820 (989)	40	11/11	DIA 20 MI

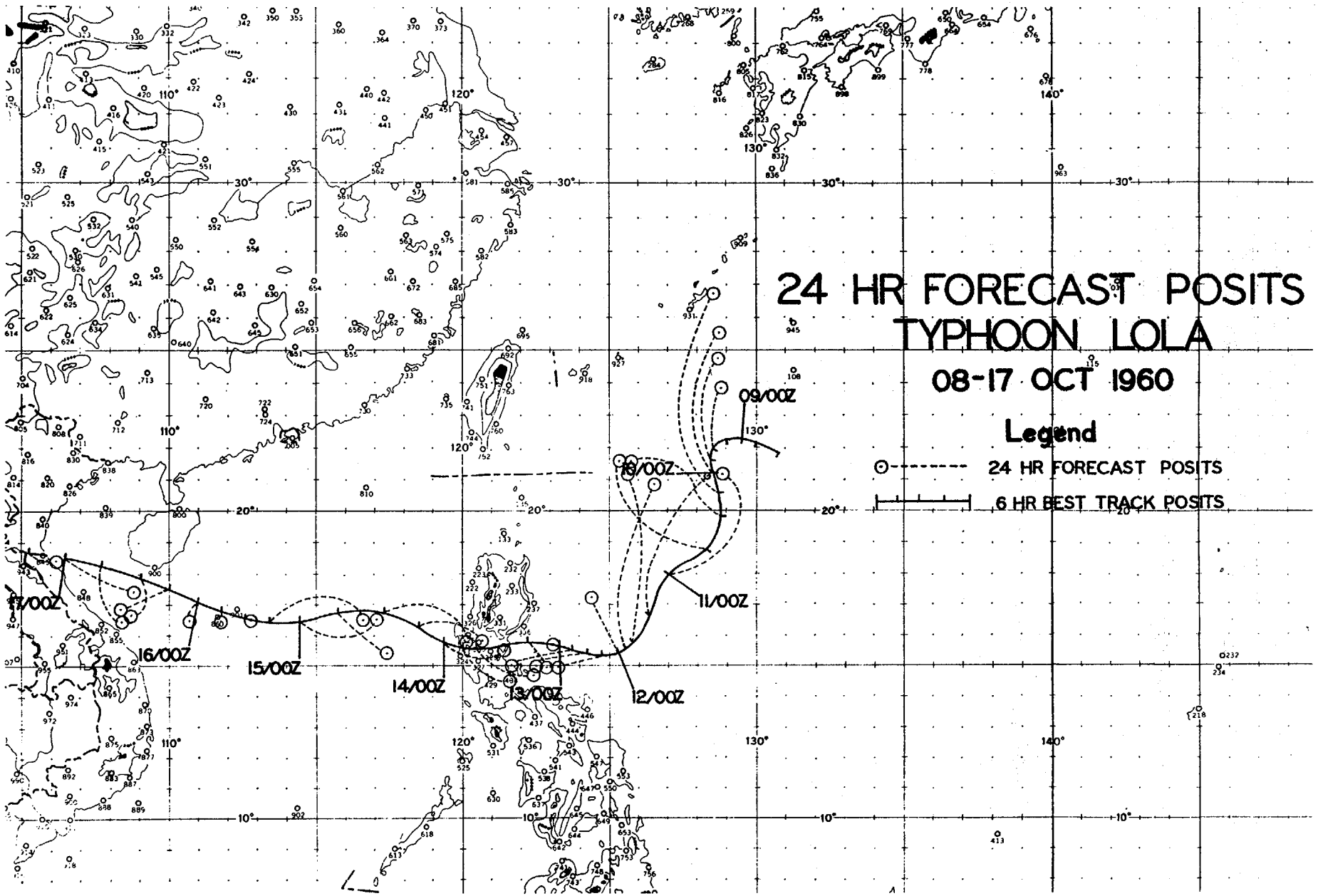
TYPHOON LOLA 08-17 OCTOBER 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
081200Z	21.8N	130.8E	- - - -	- - - -
081800Z	22.1N	130.0E	- - - -	- - - -
090000Z	22.2N	129.5E	- - - -	- - - -
090600Z	22.2N	129.0E	- - - -	- - - -
091200Z	22.0N	128.6E	010-109	- - - -
091800Z	21.7N	128.4E	008-191	- - - -
100000Z	21.2N	128.6E	003-259	- - - -
100600Z	20.6N	128.8E	359-373	- - - -
101200Z	19.9N	128.8E	302-198	005-423
101800Z	18.9N	128.3E	314-243	009-542
110000Z	18.0N	127.0E	028-212	020-743
110600Z	16.6N	126.4E	021-293	023-890
111200Z	15.8N	125.9E	358-321	338-396
111800Z	15.6N	125.6E	009-329	336-423
120000Z	15.4N	125.2E	333-113	036-348
120600Z	15.3N	124.8E	259-90	030-402
121200Z	15.3N	124.2E	261-115	355-396
121800Z	15.5N	123.8E	257-122	013-355
130000Z	15.7N	123.3E	279-17	316-157
130600Z	15.8N	122.1E	138-64	257-130
131200Z	15.5N	120.4E	110-116	270-83
131800Z	15.5N	120.0E	113-108	270-67
140000Z	15.8N	119.4E	102-113	265-95
140600Z	16.2N	118.5E	104-131	300-156
141200Z	16.7N	117.3E	088-167	301-195
141800Z	16.7N	115.9E	134-126	294-240
150000Z	16.4N	114.4E	088-150	276-278
150600Z	16.4N	113.3E	090-194	272-283
151200Z	16.6N	112.6E	292-18	273-300
151800Z	16.8N	111.9E	193-24	283-188
160000Z	17.1N	111.0E	214-45	281-205
160600Z	17.5N	110.0E	250-110	284-245
161200Z	17.8N	109.0E	193-67	338-88
161800Z	18.2N	107.7E	159-112	336-107
170000Z	18.4N	106.5E	114-153	338-120

TYPHOON LOLA 08-17 OCTOBER 1960
POSITION AND FORECAST VERIFICATION DATA (CONT'D)

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
170600Z	18.6N	105.2E	103	53	226	100

AVERAGE 24 HOUR ERROR 148 MI
AVERAGE 48 HOUR ERROR 284 MI


24 HR FORECAST POSITS
TYPHOON LOLA
08-17 OCT 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
09/00Z
10/00Z
11/00Z
12/00Z
13/00Z
14/00Z
15/00Z
16/00Z
17/00Z
110°
120°
130°
140°
30°
20°
10°

R. TYPHOON MAMIE (132200Z-210600Z OCTOBER 1960)

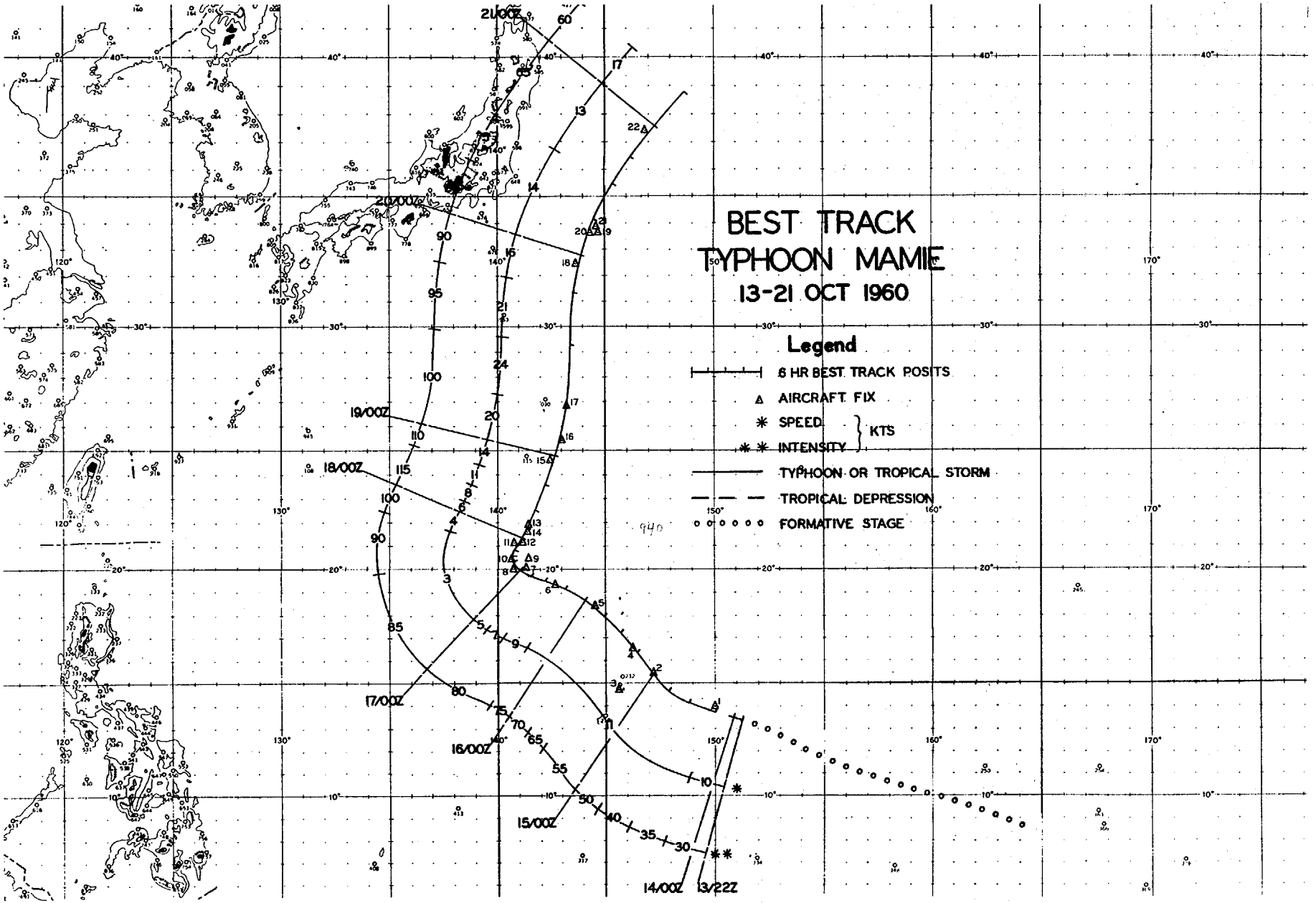
The first closed isobar was transcribed around the depression, that was to become the largest typhoon of the season, at 101800Z near Kwajalein. By the time the first warning was issued on T.D. 21, it was more than 1300 mi in diameter, encompassing an area of more than 1,300,000 square mi. At 171800Z the approximate area within the greatest closed isobar of this fully developed typhoon was 1,200,000 square mi, and the area of cyclonic circulation was twice that total. When the last warning was issued at 210600Z, Typhoon MAMIE enclosed an area of only 324,000 square mi.

The first warning was issued on MAMIE 370 mi E of Guam at 132200Z, when the maximum wind circulation about the depression was 25 kts. MAMIE moved along a WNW track at 11 kts, passing 175 mi NE of Guam at 150000Z with surface winds of 50 kts near the center. It became a typhoon at 151200Z, about 220 mi NNE of Guam. The typhoon continued to a point near 20N 141E, slowed to 3 kts, turned just E of N, and then accelerated rapidly to 24 kts over a distance of 370 mi in a period of 36 hours. MAMIE was 70 mi E of Iwo Jima at 190000Z and about 50 mi E of Peel Island at 190700Z. The typhoon passed nearest Japan at 200600Z, 275 mi ESE of Tokyo. The last warning was issued 24 hours later, after which MAMIE became extratropical. The surface winds were 60 kts at that time.

MAMIE traveled about 1950 mi from the first to last warning, and lasted 8 hours longer than one week. The minimum speed was 3 kts on 17 October; the maximum speed was 24 kts on 19 October; the average speed was 11 kts or 267 mi per day. Warnings were being issued simultaneously on Typhoons LOLA and MAMIE.

MAMIE was probably intense enough to be a closed circulation at the 200 mb level. The Iwo Jima 200 mb winds turned with the approach of MAMIE; however, the last report was received at 180600Z, due to equipment failure when the typhoon was 180 mi to the S. Consequently, reports with W wind components are not available. This was the only station along the track of MAMIE that could have provided this information.

MAMIE was the largest typhoon of the 1960 season, comparable in size to the large ones of other years. To picture the area influenced by this typhoon, consider that the surface circulation was cyclonic, covering an area bounded by Japan, the Philippines, Truk, Marcus, and then Japan.


BEST TRACK
TYPHOON MAMIE
13-21 OCT 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
21/00Z
20/00Z
19/00Z
18/00Z
17/00Z
16/00Z
15/00Z
14/00Z
13/22Z

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON MAMIE

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	140630Z	14.0N	150.0E	VW1-----	- -	- -	- - -	- -	- - -	- - - - - - - - - - - - - - -
2	142204Z	15.3N	147.1E	56-P-08	996	50	10150	54	09/05	CIRC DIA 40 MI
3	150100Z	14.8N	145.5E	VW1-R-05	- -	- -	- - -	- -	- - -	ELONG EYE DIA 40 MI
4	150715Z	16.4N	146.2E	56-P-02	985	35	9980	40	11/07	NOT DEFINED ON RADAR
5	152130Z	18.4N	144.5E	56-P-05	980	70	9740	60	12/09	NOT DEFINED
6	160800Z	19.3N	142.8E	56-P-20	979	75	9540	65	17/11	CIRC DIA 40 MI OPEN W
7	162250Z	20.1N	141.2E	56-P-05	976	60	9490	55	12/10	CIRC DIA 20 MI
8	170258Z	20.0N	140.8E	56-P-08	962	65	9410	57	12/10	CIRC DIA 35 MI
9	170439Z	20.5N	141.5E	VW1-R-10	- -	- -	- - -	- -	- - -	DIA 50 MI
10	170815Z	20.4N	140.8E	56-P-10	950	55	8940	70	15/06	CIRC DIA 40 MI
11	172130Z	21.1N	140.9E	56-P-05	948	80	8860	85	16/10	CIRC DIA 20 MI WELL DEFINED
12	180230Z	21.1N	141.1E	56-P-10	946	80	8630	90	17/11	CIRC DIA 15 MI
13	180720Z	21.9N	141.4E	56-P-10	940	80	8420	95	17/10	CIRC DIA 40 MI
14	180522Z	21.7N	141.4E	VW1-R-05	- -	- -	- - -	- -	- - -	CIRC DIA 30 MI
15	182120Z	24.7N	142.4E	56-P-15	946	40	8650	85	16/12	DIFFUSE DIA 40 MI
16	190215Z	25.3N	143.0E	56-P-05	960	- -	8630	90	16/16	CIRC DIA 35 MI
17	190615Z	26.9N	143.1E	56-P-05	958	150	8720	90	17/17	SEMICIRC DIA 30 MI
18	192200Z	32.4N	143.8E	56-P-05	966	90	9340	60	20/02	NOT DEFINED
19	200100Z	33.7N	143.7E	56-P-11	972	85	9530	80	23/03	NOT DEFINED
20	200245Z	33.7N	144.2E	56-P-20	- -	70	9530	30	21/03	NOT DEFINED

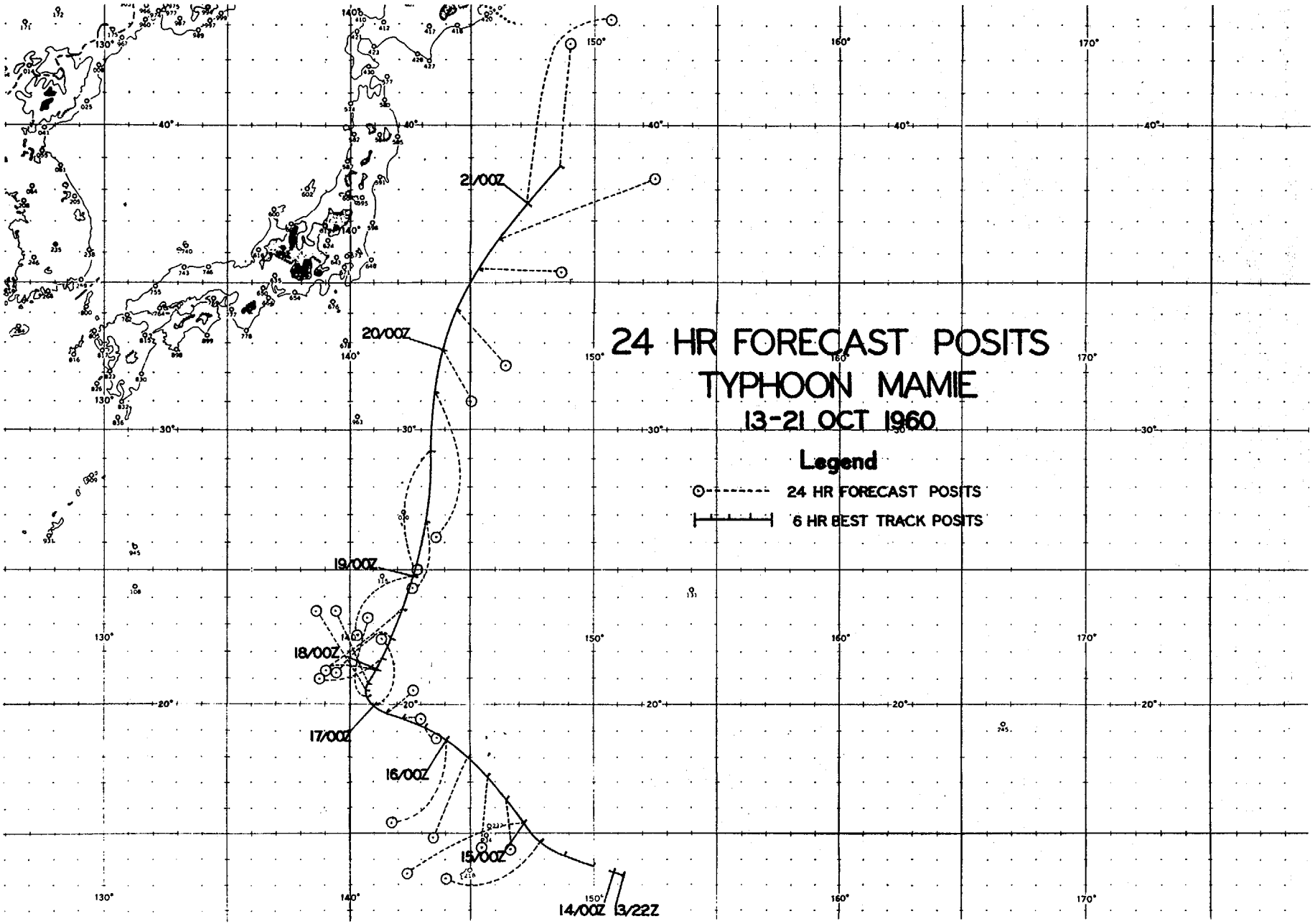
RECONNAISSANCE AIRCRAFT FIXES - TYPHOON MAMIE (CONT'D)

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
21	200545Z	33.9N	144.8E	56-P-05	980	50	9550	40	20/06	FILLED WITH SC NO WALL CLDS
22	202300Z	37.4N	146.9E	56-P-03	993	70	- - -	- -	- - -	CIRC OPEN S

TYPHOON MAMIE 13-21 OCTOBER 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
132200Z	13.3N	151.2E	- - - -	- - - -
140000Z	13.5N	150.9E	- - - -	- - - -
140600Z	13.8N	150.0E	- - - -	- - - -
141200Z	14.1N	148.9E	- - - -	- - - -
141800Z	14.6N	147.9E	- - - -	- - - -
150000Z	15.3N	147.1E	- - - -	- - - -
150600Z	16.2N	146.3E	- - - -	- - - -
151200Z	17.1N	145.7E	- - - -	- - - -
151800Z	18.0N	145.0E	204-205	- - - -
160000Z	18.7N	144.1E	213-240	- - - -
160600Z	19.1N	143.1E	119-40	- - - -
161200Z	19.5N	142.2E	093-46	- - - -
161800Z	19.7N	141.5E	055-86	205-226
170000Z	20.0N	141.1E	009-145	221-366
170600Z	20.2N	140.8E	001-179	007-70
171200Z	20.6N	140.8E	336-185	344-87
171800Z	20.9N	140.9E	326-200	351-151
180000Z	21.3N	141.1E	271-114	351-275
180600Z	21.8N	141.3E	252-144	353-295
181200Z	22.5N	141.7E	237-151	323-311
181800Z	23.5N	142.2E	232-220	312-325
190000Z	24.8N	142.7E	223-183	240-326
190600Z	26.8N	143.1E	191-151	220-422
191200Z	29.2N	143.3E	185-261	210-525
191800Z	31.3N	143.5E	179-307	208-631
200000Z	32.8N	143.9E	153-122	200-512
200600Z	34.1N	144.5E	143-153	178-383
201200Z	35.4N	145.3E	- - - -	- - - -
201800Z	36.5N	146.1E	- - - -	- - - -
210000Z	37.6N	147.1E	- - - -	- - - -
210600Z	38.8N	148.6E	- - - -	- - - -

AVERAGE 24 HOUR ERROR 165 MI
AVERAGE 48 HOUR ERROR 327 MI


24 HR FORECAST POSITS
TYPHOON MAMIE
13-21 OCT 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
21/00Z
20/00Z
19/00Z
18/00Z
17/00Z
16/00Z
15/00Z
14/00Z
13/22Z

S. TYPHOON NINA (230000Z-271800Z OCTOBER 1960)

In the wake of Typhoon MAMIE there was a collection of debris in the form of small vortices between the Philippine Islands and Guam. Before 200000Z these vortices appeared to form and dissipate frequently; however, at this time a low appeared and ultimately became Typhoon NINA.

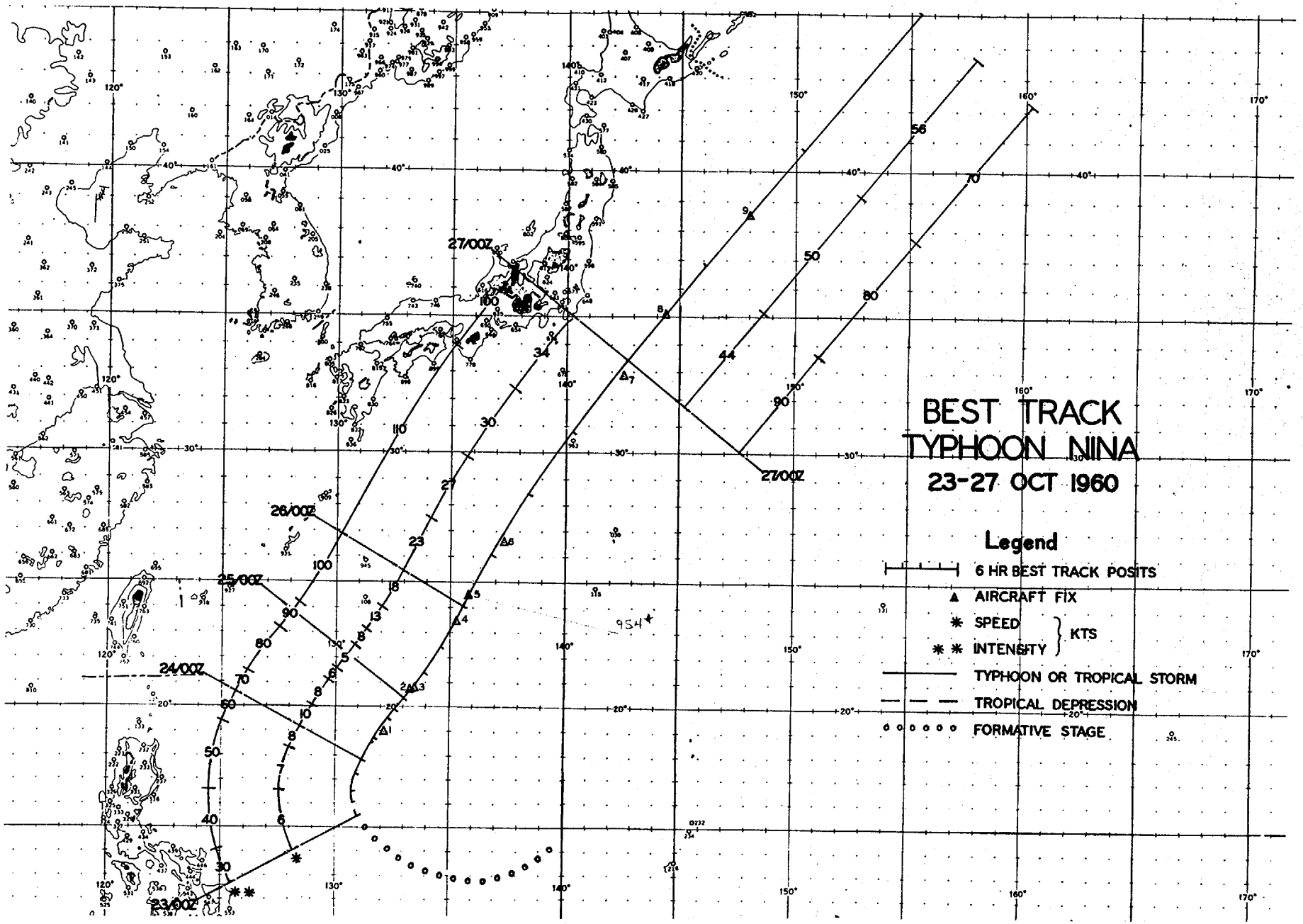
The first warning on T.D. 23 was issued at 230000Z after the depression had moved slowly to the W and NW for several days. The low had just entered into recurvature and was about 600 mi E of Clark AB, Philippines at the time of the first warning. Recurvature was completed 24 hours later; at that time NINA reached typhoon intensity. After 240000Z NINA traveled in an almost straight line, along a track of about 030 degrees. The surface winds near the eye of NINA continued to steadily increase in speed at the rate of 5 to 10 kts each 6 hours, until a maximum of 110 kts was reached at 260000Z when the typhoon was 320 mi W of Minami Io Jima, an island just S of Iwo Jima. NINA passed to the W and within 20 mi of Tori Shima between 261700Z and 261800Z, moving at 30 kts. The surface winds reached 40 kts and the pressure dropped to 954 mb or less at that station. The Tori Shima weather station is well protected against high winds from a southerly direction; hence no higher winds were reported. The typhoon passed 200 mi SE of Tokyo at 270000Z and continued parallel to the Japanese Archipelago until 271800Z when the last warning was issued. NINA was moving at 56 kts and had 70 kt surface winds at this time.

The "warning life" of NINA was 4 days and 18 hours, during which time the typhoon traveled 2200 mi at an average speed of 19 kts or 460 mi per day. The minimum speed was 5 kts on 24 and 25 October, and the maximum speed was 56 kts on 27 October.

The winds aloft at Tori Shima(47963) and Hachijo Jima (47678) are interesting because of the effect of Typhoon NINA on them. Hachijo Jima's 261800Z winds at 25,000 ft strongly suggest a closed circulation; however, the 30,000 ft winds, which were 230 degrees 54 kts at 260600Z, became 220 degrees 17 kts at 261800Z, and then became 250 degrees 68 kts at 270000Z when the influence of NINA no longer existed. The winds at Tori Shima were modified from 251800Z until after the passage of the typhoon there. Prior to that time the 30,000 ft wind was 260 degrees with speeds ranging from 60 to 75 kts; by 260600Z the winds were only 220 degrees 25 kts. The speed increased to 64 kts just before the typhoon passed and the direction changed to 200 degrees. Shortly after passage the winds returned to the prevailing flow (260 degrees 49 kts) at the 300 mb level. The typhoon

in effect decreased the prevailing westerly wind speed at 30,000 ft as it approached that area from the S. NINA appeared to be a closed cyclonic circulation at 20-25,000 ft when in the vicinity of Tori Shima and Hachijo Jima.

The typhoon was not unusual in behavior. Typhoon NINA was the second "fastest" typhoon of the season, averaging 56 kts for the last 6 hours of its "warning life".


BEST TRACK
TYPHOON NINA
23-27 OCT 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
23/00Z
24/00Z
25/00Z
26/00Z
27/00Z
27/00Z
954+

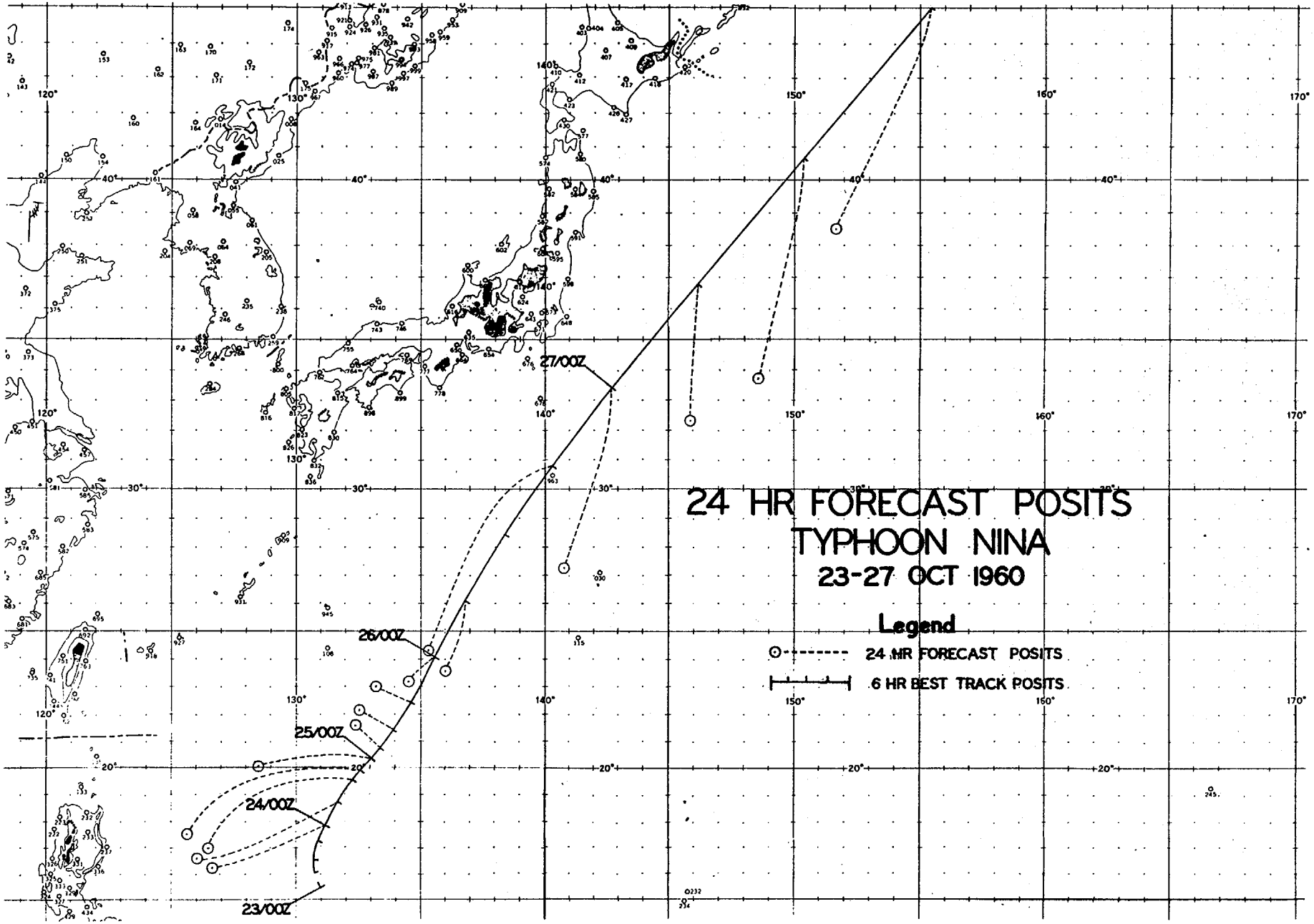
RECONNAISSANCE AIRCRAFT FIXES - TYPHOON NINA

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	240815Z	19.0N	132.1E	56-P-05	962	65	9480 (977)	60	17/10	CIRC DIA 05MI NO WALL CLDS
2	250545Z	20.8N	133.4E	56-P-05	954	70	9030	70	15/13	NOT DEFINED WALL CLDS E&N
3	250800Z	20.8N	133.5E	56-P-05	962	90	9010 (961)	105	15/13	CIRC DIA 40 MI
4	252100Z	23.4N	135.1E	56-P-05	957	70	8860 (956)	90	16/11	CIRC DIA 50 MI WALL CLDS SOLID EXCEPT SW
5	260145Z	24.5N	135.7E	56-P-15	958	95	8810 (954)	90	19/10	CIRC DIA 50 MI
6	260750Z	26.6N	137.3E	56-P-05	968	120	8900 (958)	110	17/13	POORLY DEFINED
7	262300Z	32.9N	142.7E	56-P-10	960	100	9050 (962)	60	18/10	CIRC NO WALL CLDS
8	270300Z	35.1N	144.3E	56-P-10	963	75	9040 (962)	85	17/09	CIRC DIA 30 MI OPEN S&SW
9	270800Z	38.4N	148.0E	56-P-10	972	100	9200 (968)	100	13/07	VERY POORLY DEFINED DIA 50-70 MI

TYPHOON NINA 23-27 OCTOBER 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
230000Z	15.4N	131.0E	- - - -	- - - -
230600Z	16.0N	130.8E	- - - -	- - - -
231200Z	16.6N	130.7E	- - - -	- - - -
231800Z	17.2N	130.9E	- - - -	- - - -
240000Z	17.9N	131.2E	- - - -	- - - -
240600Z	18.8N	131.8E	- - - -	- - - -
241200Z	19.5N	132.3E	- - - -	- - - -
241800Z	19.9N	132.6E	- - - -	- - - -
250000Z	20.3N	133.0E	266-257	- - - -
250600Z	20.7N	133.4E	311-74	- - - -
251200Z	21.4N	133.9E	300-81	- - - -
251800Z	22.4N	134.6E	292-82	- - - -
260000Z	24.1N	135.5E	225-80	251-358
260600Z	26.1N	136.7E	196-148	232-77
261200Z	28.4N	138.2E	202-318	210-184
261800Z	30.8N	140.2E	205-458	203-153
270000Z	33.4N	142.9E	196-392	208-463
270600Z	36.8N	146.3E	- - - -	- - - -
271200Z	40.8N	150.2E	- - - -	- - - -
271800Z	45.0N	155.3E	- - - -	- - - -

AVERAGE 24 HOUR ERROR 210 MI
AVERAGE 48 HOUR ERROR 247 MI

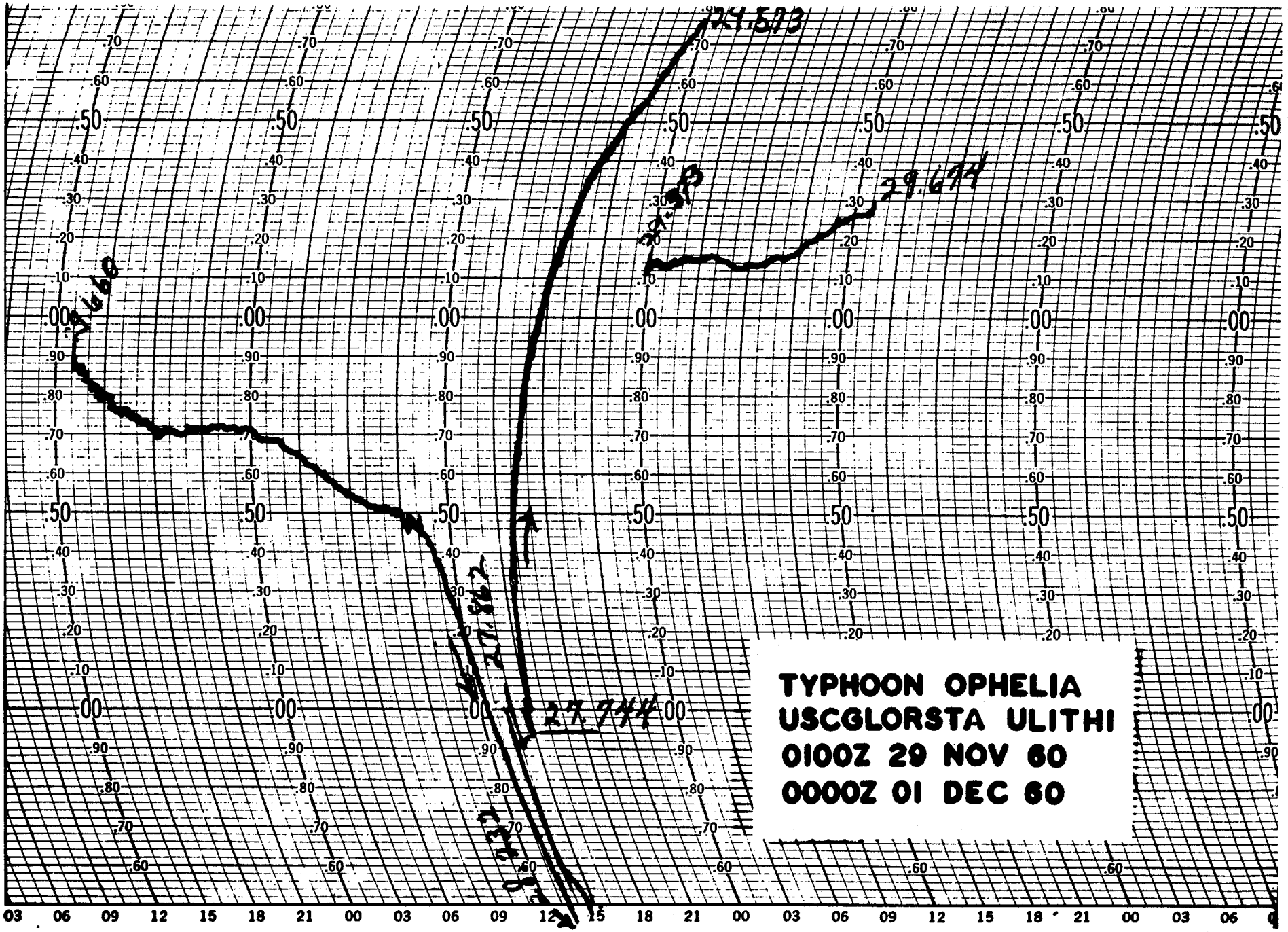

24 HR FORECAST POSITS
TYPHOON NINA
23-27 OCT 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
27/00Z
26/00Z
25/00Z
24/00Z
23/00Z

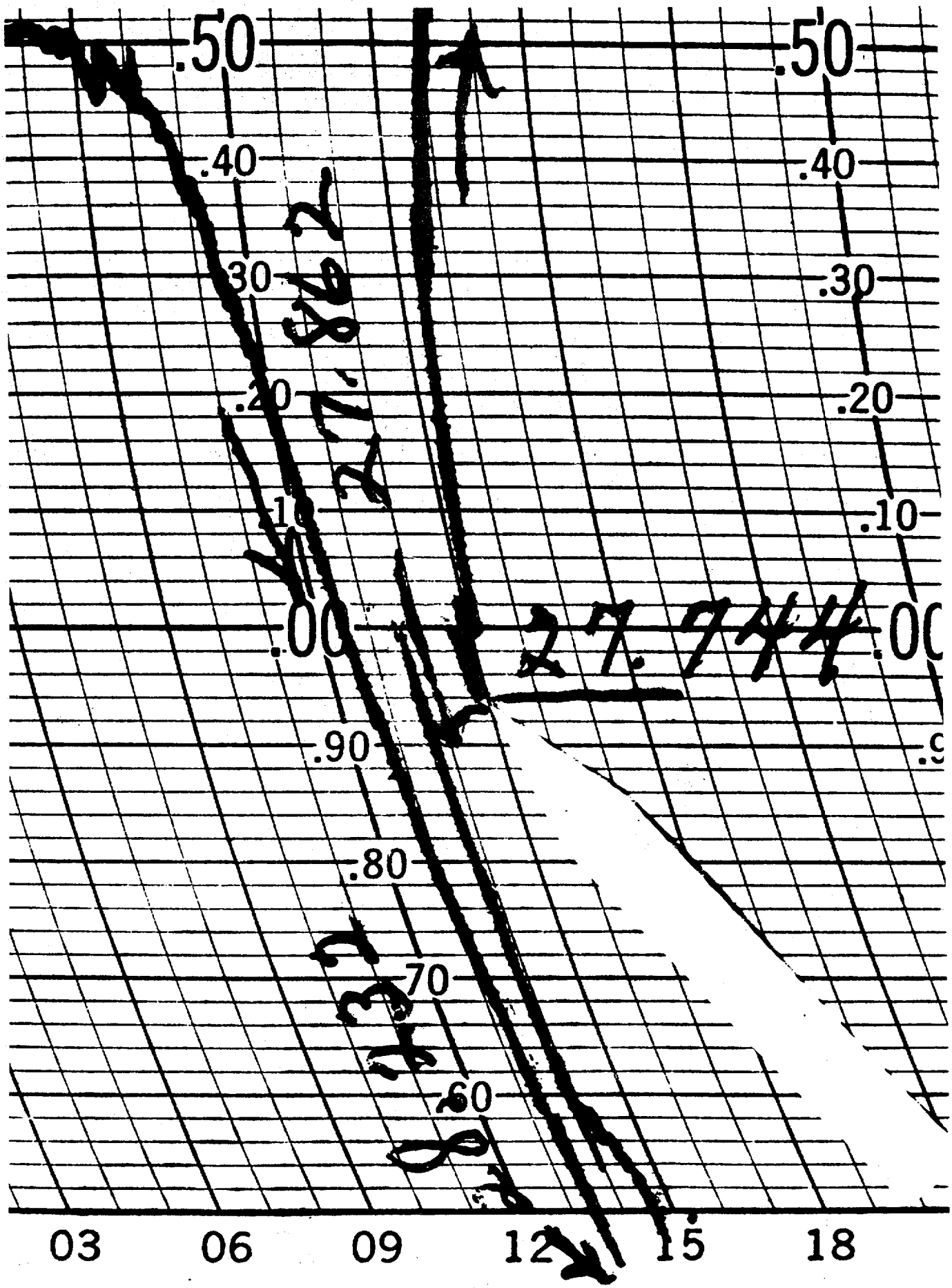
T. TYPHOON OPHELIA (211200Z NOVEMBER-060600Z DECEMBER 1960)

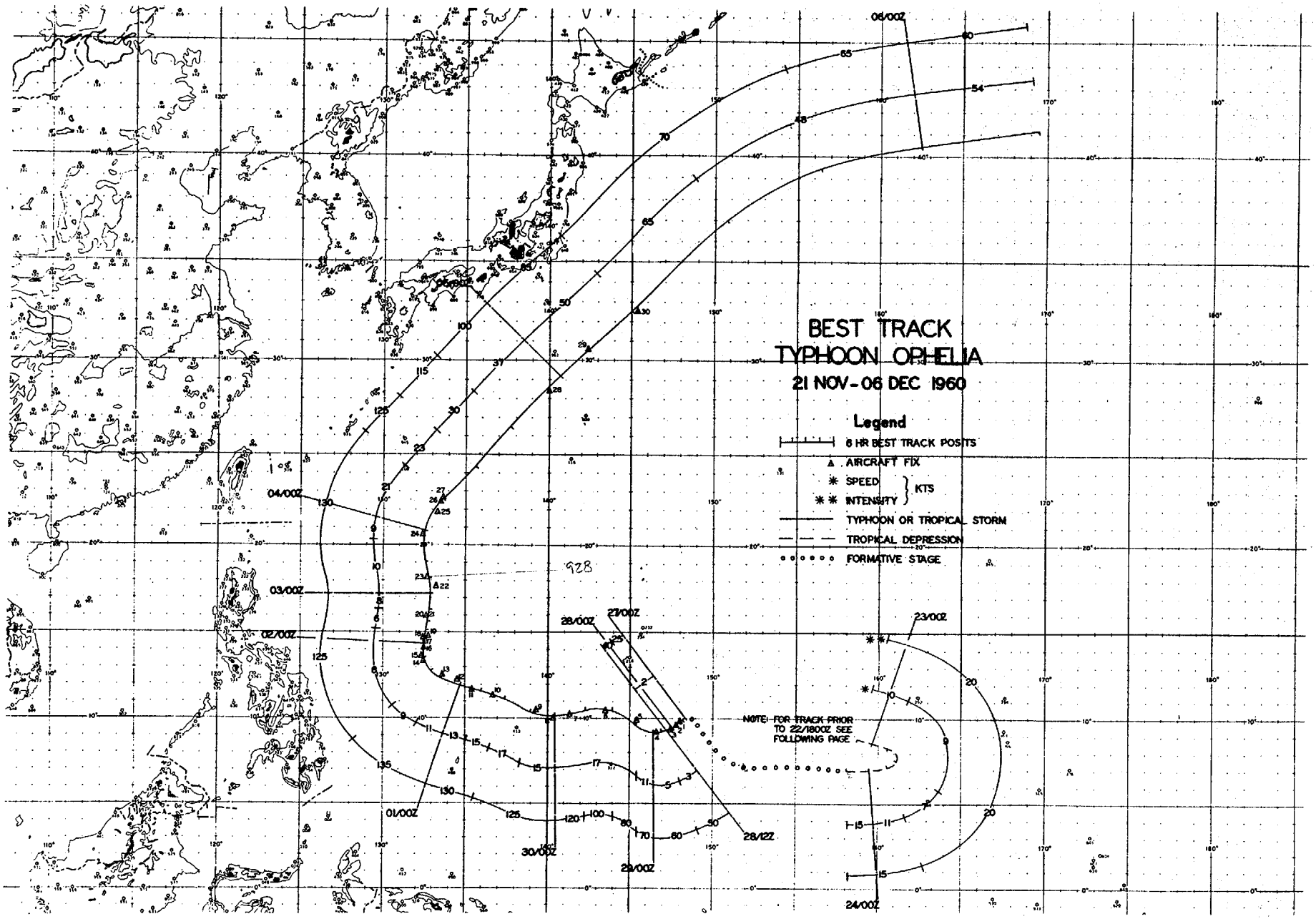
A shift of the surface wind at Kwajalein and the development of a small low just S of that station presaged Typhoon OPHELIA. The depression intensified as it moved W to a point 165 mi SW of Eniwetok, the position of the first warning at 211200Z on T.D. 24. As is often the case, quirks of nature confuse the situation. Shortly after the first warning was issued the system began to weaken and it appeared that the low would lose its identity. Warnings were discontinued at 240600Z, by which time the depression had reversed direction twice and was moving W in the vicinity of Ponape. Although warnings were not being issued, this circulation was carefully surveyed as it moved W, passed Truk, then turned NW and intensified again. At 270000Z, when the depression was 290 mi SE of Guam, the issuance of warnings was resumed. The depression increased to tropical storm intensity at 271800Z and to typhoon intensity at 290000Z. The speed of movement increased from 2 kts at 270000Z to 17 kts at 290600Z, at which time it was 240 mi S of Guam. The track followed a semi-sinusoidal pattern, creating a difficult forecast problem. Typhoon OPHELIA passed directly over Ulithi Atoll at 300300Z. The pressure was reported to be a minimum of 939.4 mb, and the winds were on the order of 125 kts. A facsimile of the barograph trace is shown here, and a photograph of damage is reproduced in another section. Ulithi Atoll was the only island or land mass over which the eye passed while warnings were being issued. Typhoon OPHELIA moved WNW to a point about 500 mi E of Catanduanes Island, Philippines at 011200Z, and then began to turn N. The change in direction was completed within 12 hours. The typhoon continued on this N track for about 2 days and traveled approximately 400 mi before completing the final turn of recurvature. OPHELIA moved NE and accelerated rapidly as it was influenced by very strong SW winds above the 500 mb level. On 5 December Typhoon OPHELIA moved about 1,275 mi at an average speed of 53 kts. The typhoon turned to the ENE at 051200Z, about 500 mi E of Tokyo. OPHELIA was classified as extratropical at 060600Z near 41N 169E, and the last warning was issued at this time.

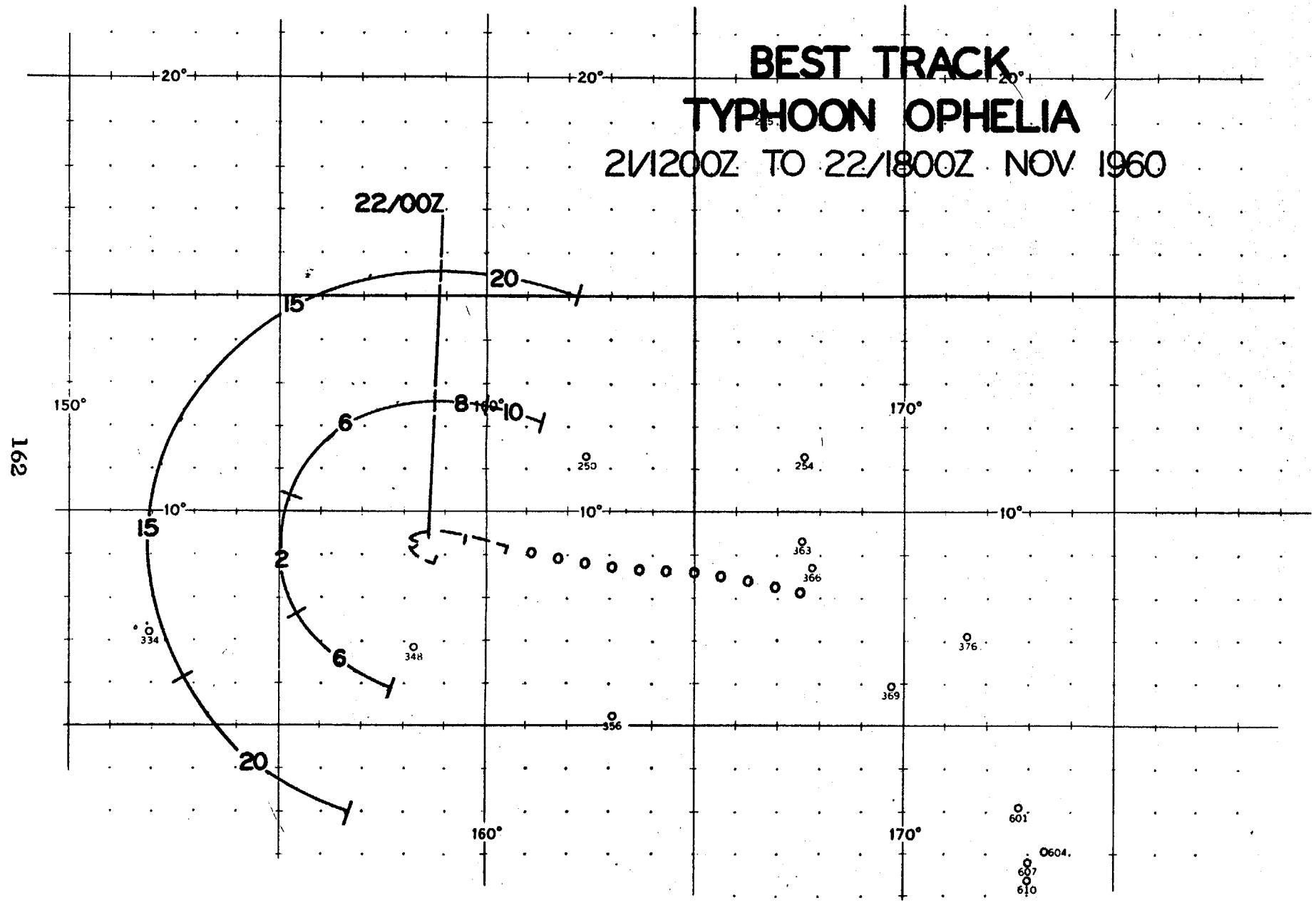
Typhoon OPHELIA traveled 5,000 mi at an average speed of 13 kts or 318 mi per day. The minimum speed was 2 kts on 22, 27 and 28 November, and the maximum speed was 65 kts on 5 December. Warnings were issued over a period of 15 days and 18 hours; however, no warnings were issued from 240600Z to 270000Z, which is included in this overall period of time.

Between 050600Z and 051200Z OPHELIA's average speed of movement was 65 kts, which is faster than any other typhoon of the Season.


TYPHOON OPHELIA
USCGLORSTA ULITHI
0100Z 29 NOV 60
0000Z 01 DEC 60
29.694
29.503
27.944
03 06 09 12 15 18 21 00 03 06 09 12 15 18 21 00 03 06 09 12 15 18 21 00 03 06


.50
.40
.30
.20
.10
.00
.90
.80
.70
.60
03
06
09
12
15
18


BEST TRACK
TYPHOON OPHELIA
21 NOV - 06 DEC 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
NOTE: FOR TRACK PRIOR TO 22/1800Z SEE FOLLOWING PAGE
06/00Z
04/00Z
03/00Z
02/00Z
01/00Z
30/00Z
29/00Z
28/00Z
28/12Z
27/00Z
24/00Z
23/00Z


BEST TRACK
TYPHOON OPHELIA
21/1200Z TO 22/1800Z NOV 1960
22/00Z
20
15
10
6
2
6
15
20
8
10
20°
150°
160°
170°
10°
162
250
254
363
366
334
348
376
369
356
601
0604
607
610

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON OPHELIA

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	270800Z	09.9N	148.0E	56-P-05	982	25	10070 998	30	11/05	CIRC DIA 15 MI WALL CLDS ALL QUADS
2	272215Z	09.7N	147.9E	56-P-10	993	35	9940 993	45	11/08	POORLY DEFINED
3	280805Z	09.3N	147.5E	56-P-05	995	40	9900 992	50	10/10	DIFFUSE
4	282210Z	09.2N	146.7E	56-P-05	974	50	9520 979	- -	15/12	ELLIP N-S 14X10 MI
5	290715Z	09.9N	145.3E	56-P-02	- -	50	9270 990	72	16/12	ILL-DEFINED CIRC DIA 30MI
6	291325Z	10.4N	143.5E	VW1-R-03	- -	- -	- - -	- -	- - -	CIRC DIA 36 MI WELL DEFINED
7	292145Z	10.2N	141.2E	56-P-08	950	125	8710 951	115	18/10	CIRC DIA 35 MI
8	300200Z	10.0N	140.2E	56-P-05	946	125	8570 945	105	18/--	ELLIP N-S 25 MI E-W 17 MI
9	300652Z	10.5N	139.2E	56-P-05	936	100	8430 941	112	17/--	CIRC DIA 40 MI
10	301500Z	11.2N	136.7E	VW1-R-05	- -	- -	- - -	- -	- - -	CIRC DIA 35 MI
11	302108Z	11.7N	135.2E	56-P-10	938	100	8370 938	110	19/18	WALL CLDS WELL DEFINED
12	010155Z	12.2N	134.5E	56-P-10	934	175	8460 942	110	28/17	DIA 15 MI
13	010700Z	12.6N	133.7E	56-P-10	942	140	8330 937	- -	18/15	CIRC OPEN E
14	011449Z	13.2N	132.3E	VW1-R-10	- -	- -	- - -	- -	- - -	OPEN NE SEMICIRCLE
15	011608Z	13.7N	132.2E	VW1-R-20	- -	- -	- - -	- -	- - -	OPEN NE SEMICIRCLE
16	012315Z	14.1N	132.5E	56-P-05	945	110	8570 945	80	18/15	- - - - - - - - - - - - - -
17	020120Z	14.5N	132.4E	56-P-05	- -	110	8430 941	90	15/14	FILLED WITH 6/8 SC
18	020300Z	14.7N	132.4E	56-P-05	938	110	8430 941	90	18/16	CIRC DIA 30 MI

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON OPHELIA (CONT'D)

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
19	020800Z	14.8N	132.8E	56-P-10	936	80	8410 (940)	80	17/17	CIRC DIA 25 MI OPEN NE
20	021356Z	16.0N	132.7E	VW1-R-10	- -	- -	- - -	- -	- - -	OPEN NE
21	021500Z	16.0N	132.7E	VW1-R-05	- -	- -	- - -	- -	- - -	CIRC DIA 25 MI
22	030300Z	17.7N	133.1E	56-P-10	929	90	8080 (928)	100	17/14	CIRC DIA 25 MI
23	030625Z	18.1N	132.8E	56-P-03	928	90	7960 (924)	100	17/14	CIRC DIA 25 MI WELL DEFINED
24	032230Z	20.6N	132.4E	56-P-07	930	130	8220 (924)	150	17/14	ELLIP E-W 30 MI
25	040230Z	21.9N	133.2E	56-P-10	931	150	8260 (935)	120	18/15	CIRC DIA 20 MI OPEN SW
26	040433Z	22.5N	133.6E	VW1-R-10	- -	- -	- - -	- -	- - -	CIRC DIA 16 MI
27	040700Z	22.7N	133.8E	56-P-05	944	110	8280 (935)	115	20/17	CIRC DIA 25 MI
28	042236Z	28.4N	140.0E	56-P-03	963	85	9070 (943)	60	16/12	OPEN NE-SE
29	050242Z	30.5N	142.2E	56-P-01	974	120	9270 (970)	45	16/11	POORLY DEFINED
30	050630Z	32.5N	145.3E	56-P-05	980	115	9420 (975)	115	17/06	POORLY DEFINED

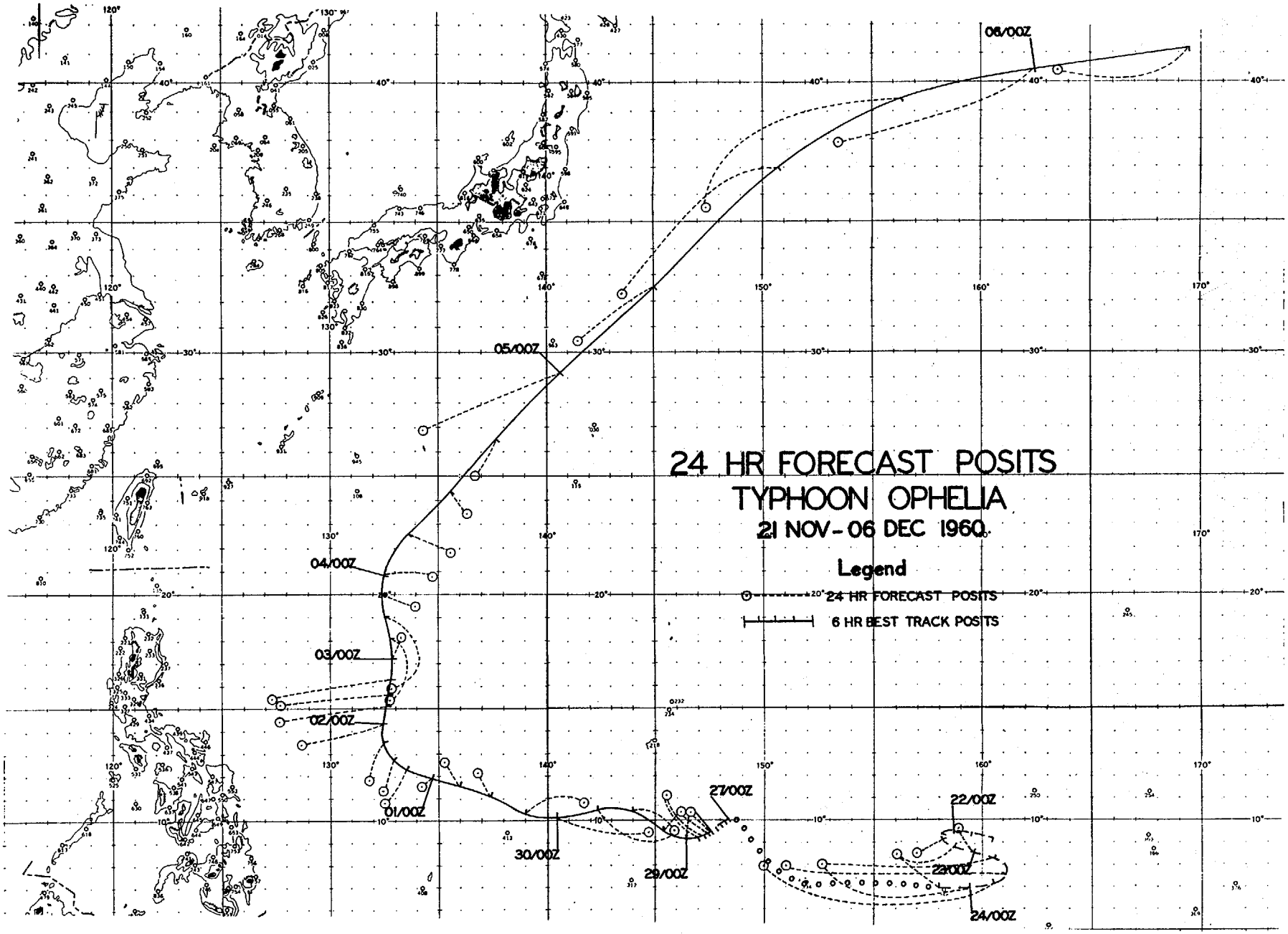
TYPHOON OPHELIA 21 NOVEMBER-06 DECEMBER 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
211200Z	09.2N	160.5E	- - - -		- - - -	
211800Z	09.4N	159.5E	- - - -		- - - -	
220000Z	09.5N	158.7E	- - - -		- - - -	
220600Z	09.4N	158.1E	- - - -		- - - -	
221200Z	09.2N	158.2E	- - - -		- - - -	
221800Z	08.9N	158.7E	- - - -		- - - -	
230000Z	08.6N	159.6E	- - - -		- - - -	
230600Z	08.2N	160.6E	- - - -		- - - -	
231200Z	07.5N	161.1E	- - - -		- - - -	
231800Z	07.1N	160.6E	- - - -		- - - -	
240000Z	07.0N	159.5E	- - - -		- - - -	
240600Z	07.0N	157.9E	- - - -		- - - -	
240600Z TO 270000Z NO WARNINGS ISSUED						
270000Z	10.0N	148.3E	- - - -		- - - -	
270600Z	09.9N	148.2E	- - - -		- - - -	
271200Z	09.8N	148.0E	- - - -		- - - -	
271800Z	09.7N	147.8E	- - - -		- - - -	
280000Z	09.5N	147.6E	317	71	- - - -	
280600Z	09.4N	147.5E	312	107	- - - -	
281200Z	09.3N	147.2E	316	150	- - - -	
281800Z	09.2N	147.0E	323	145	- - - -	
290000Z	09.1N	146.5E	010	67	314	191
290600Z	09.6N	145.4E	036	65	315	165
291200Z	10.4N	144.0E	115	131	325	119
291800Z	10.4N	142.2E	105	226	031	101
300000Z	10.1N	140.5E	099	251	074	245
300600Z	10.3N	139.0E	078	157	077	298
301200Z	11.1N	137.4E	331	66	103	440
301800Z	11.6N	136.0E	320	75	105	517
010000Z	12.0N	134.8E	234	47	105	450
010600Z	12.3N	133.6E	222	116	096	235
011200Z	12.8N	132.9E	200	97	292	188
011800Z	13.5N	132.4E	202	103	284	270
020000Z	14.3N	132.4E	254	213	259	268

TYPHOON OPHELIA 21 NOVEMBER-06 DECEMBER 1960
POSITION AND FORECAST VERIFICATION DATA (CONT'D)

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
020600Z	15.1N	132.5E	262-285	245-327
021200Z	15.7N	132.7E	263-287	246-326
021800Z	16.2N	132.9E	261-327	230-347
030000Z	17.1N	133.0E	016-67	254-540
030600Z	18.1N	132.9E	182-152	258-582
031200Z	19.0N	132.6E	174-128	257-535
031800Z	20.0N	132.5E	112-93	255-570
040000Z	20.9N	132.5E	091-129	075-356
040600Z	22.6N	133.7E	118-109	183-237
041200Z	24.3N	135.5E	146-71	198-324
041800Z	26.5N	137.8E	213-103	198-220
050000Z	29.1N	140.7E	249-366	198-173
050600Z	32.6N	145.0E	235-218	215-377
051200Z	37.0N	150.9E	- - - -	- - - -
051800Z	39.4N	156.2E	- - - -	- - - -
060000Z	40.3N	162.3E	- - - -	- - - -
060600Z	41.1N	169.3E	- - - -	- - - -

AVERAGE 24 HOUR ERROR 147 MI
AVERAGE 48 HOUR ERROR 323 MI


24 HR FORECAST POSITS
TYPHOON OPHELIA
21 NOV - 06 DEC 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
06/00Z
05/00Z
04/00Z
03/00Z
02/00Z
01/00Z
30/00Z
29/00Z
27/00Z
22/00Z
23/00Z
24/00Z

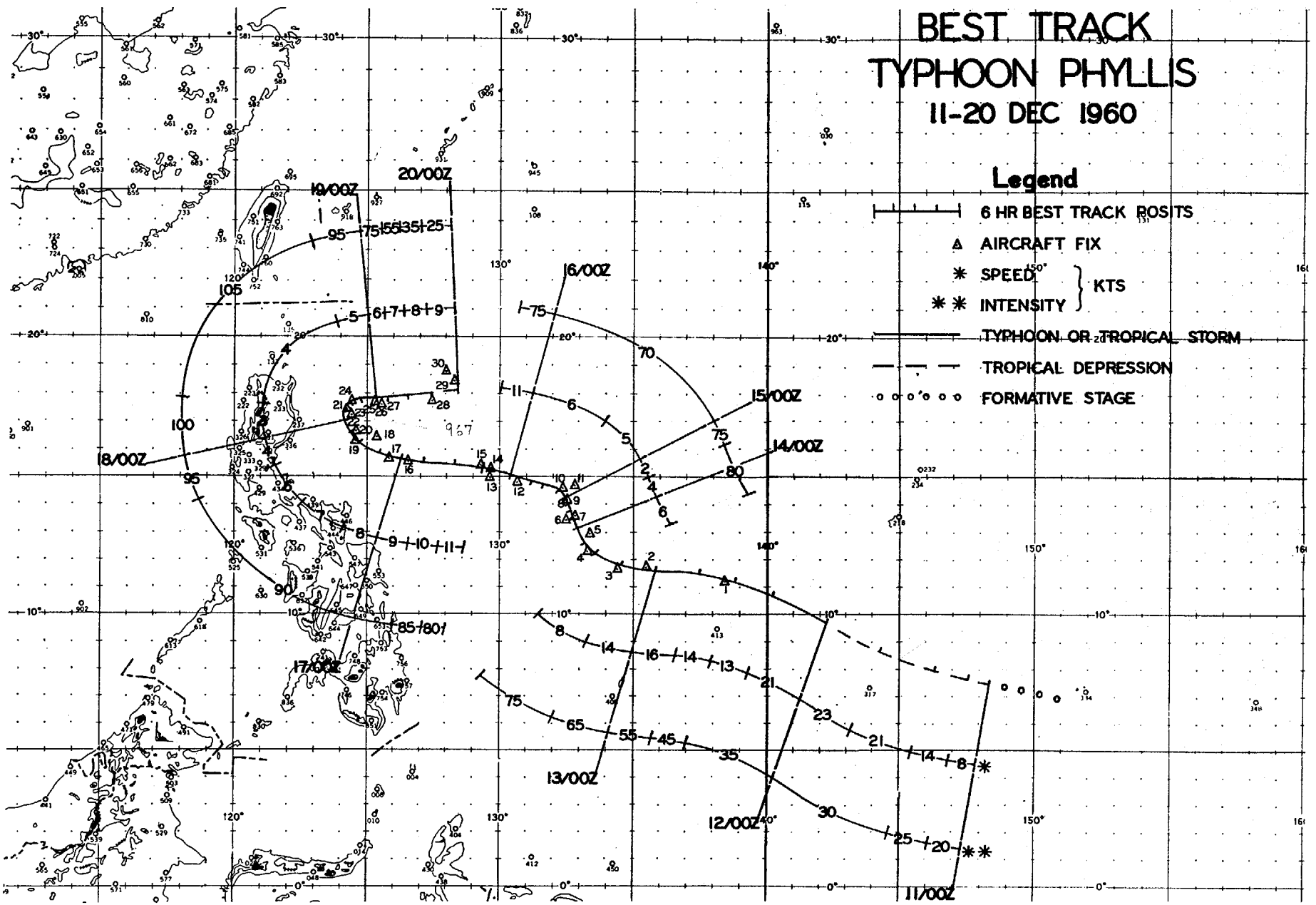
U. TYPHOON PHYLLIS (110000Z-200000Z DECEMBER 1960)

A cyclonic circulation was evident about 100 mi W of Truk on the 090600Z surface chart. This system moved W, and at 110000Z the initial warning was issued on T.D. 25 in the vicinity of 7N 148E. This cyclone moved WNW to W for the first 60 hours that warnings were issued; the depression was upgraded to T.S. PHYLLIS at 120000Z near 10N 142E. The average speed of movement of PHYLLIS for the first 60 hours that warnings were issued was 15 kts. This is a relatively fast speed for a tropical disturbance in low latitudes, but the 300 mb charts from 101200Z to 131200Z indicated a stronger than normal gradient throughout this region, which undoubtedly had an effect on the speed.

The storm passed 40 mi N of Ulithi at 120730Z. The maximum reported surface wind speed at this atoll was 20 kts, and the minimum sea level pressure was 998.3 mb. The sea level pressure at Yap and Koror did not fall below 1,000 mb, which indicated that PHYLLIS was still a small storm. After it passed Ulithi it rapidly intensified, reaching typhoon strength by 130000Z near 12N 136E. At this time the 200 mb chart showed an elongated high just N of PHYLLIS, extending from S of Marcus to the Philippines. This high split into two separate cells, and the typhoon began to move N around the western edge of the anticyclone which was E of PHYLLIS. It then moved into a col area between the two highs; this slowed its speed of movement to 3 kts. The 200 mb high, which was E of PHYLLIS, began to spread its influence over PHYLLIS again. This resulted in PHYLLIS turning to the W and accelerating to 11 kts by 160000Z. After 161200Z PHYLLIS began to turn slowly toward the NW and its speed of movement decreased. From 171200Z to 181800Z the typhoon changed its direction of movement from 300 to 080 degrees as it rapidly recurved. Its speed during recurvature slowed to 4 kts, and the maximum surface wind speed increased to 105 kts by 180600Z.

A cold front was located about 300 mi N of PHYLLIS at 181200Z, and it moved S as the typhoon moved E. This front brought cold air into the typhoon, causing it to rapidly weaken and to become extratropical. At 182330Z a reconnaissance fix indicated maximum sustained surface winds of 110 kts, and at 192325Z a reconnaissance fix indicated winds of only 15 kts and a poorly defined center. The final warning was issued at 200000Z.

A total of 37 warnings were issued, covering a period of 9 days. PHYLLIS traveled 1850 mi, averaging 9 kts or 207 mi per day. The minimum speed of movement was 2 kts on 14 Dec., and the maximum speed was 23 kts on 11 Dec.


BEST TRACK
TYPHOON PHYLLIS
11-20 DEC 1960
Legend
6 HR BEST TRACK POSITS
AIRCRAFT FIX
SPEED
INTENSITY
KTS
TYPHOON OR TROPICAL STORM
TROPICAL DEPRESSION
FORMATIVE STAGE
20/00Z
19/00Z
16/00Z
15/00Z
14/00Z
18/00Z
17/00Z
13/00Z
12/00Z
11/00Z
967

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON PHYLLIS

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
1	121517Z	11.1N	138.4E	USAF-R--	- -	- -	- - -	- -	- - -	- - - - - - - - - - - - - -
2	130030Z	11.8N	135.5E	56-P-03	995	65	9980 995	40	15/09	ELLIP N-S 10MI E-W 25MI
3	130630Z	11.7N	134.4E	56-P-03	982	75	9680 984	55	15/10	CIRC DIA 20 MI OPEN N
4	131455Z	12.2N	133.2E	VW1-R-08	- -	- -	- - -	- -	- - -	CIRC DIA 40 MI
5	132300Z	13.0N	133.3E	56-P-05	977	60	9550 980	55	14/--	DIFFUSE
6	140300Z	13.3N	132.9E	56-P-05	984	60	9520 977	70	13/--	DIFFUSE, DIA 40 MI
7	140730Z	13.5N	132.9E	56-P-10	980	70	9510 979	70	16/15	CIRC DIA 40 MI OPEN N & NE
8	141500Z	14.1N	132.5E	VW1-R-20	- -	- -	- - -	- -	- - -	OPEN DIA 25 MI
9	150030Z	14.0N	132.6E	56-P-05	979	50	9820 989	50	20/16	DIFFUSE, WALL CLDS E & S
10	150315Z	14.6N	132.3E	56-P-15	990	60	9850 990	50	19/16	POORLY DEFINED & DIFFUSE
11	150700Z	14.7N	132.9E	56-P-05	982	65	9750 987	60	16/12	POORLY DEFINED & DIFFUSE
12	152315Z	14.8N	130.7E	56-P-05	984	55	9740 987	60	16/13	CIRC POORLY DEFINED
13	160308Z	15.9N	129.7E	VW1-R-15	- -	- -	- - -	- -	- - -	CIRC DIA 33 MI
14	160330Z	15.1N	129.7E	56-P-07	973	55	9650 983	60	17/16	CIRC DIA 50 MI OPEN S & W
15	160700Z	15.3N	129.2E	56-P-05	964	70	9530 979	65	16/15	CIRC DIA 40 MI WALL CLDS S&W
16	162145Z	15.5N	126.5E	56-P-04	985	- -	9350 973	75	15/--	- - - - - - - - - - - - - -
17	170230Z	15.7N	125.9E	56-P-02	971	60	9400 974	75	15/--	CIRC DIA 20 MI
18	171015Z	16.3N	125.2E	56-P-05	- -	- -	9360 973	60	14/11	CIRC DIA 15 MI
19	171126Z	16.2N	124.7E	VW1-R-10	- -	- -	- - -	- -	- - -	- - - - - - - - - - - - - -
20	171457Z	16.6N	124.6E	VW1-R-10	- -	- -	- - -	- -	- - -	CIRC DIA 20 MI

RECONNAISSANCE AIRCRAFT FIXES - TYPHOON PHYLLIS (CONT'D)

FIX NO.	TIME	LAT.	LONG.	UNIT METHOD & ACCY	MIN SLP MBS	MAX SFC WND	MIN 700MB HGT	MAX 700MB WND	700MB TT/Td (°C)	EYE CHARACTERISTICS
21	172230Z	17.4N	124.2E	56-P-08	972	- -	9330 (972)	70	14/11	CIRC DIA 50 MI
22	180330Z	17.2N	124.3E	56-P-05	962	65	9230 (969)	85	20/--	CIRC DIA 50 MI
23	180900Z	17.6N	124.2E	56-P-02	967	110	9110 (965)	90	19/--	CIRC DIA 25 MI
24	181430Z	17.7N	124.3E	VW1-R-02	- -	- -	- - -	- -	- - -	CIRC DIA 20 MI
25	182330Z	17.8N	125.3E	56-P-05	979	110	9780 (989)	- -	21/14	WALL CLDS NW
26	190500Z	17.7N	125.5E	56-P-02	987	65	9880 (991)	- -	19/09	OPEN S SEMICIRCLE
27	190800Z	17.7N	125.7E	56-P-03	994	75	10000 (996)	- -	18/10	ELLIP CTR TO W 12 MI CTR TO N 20 MI
28	191607Z	17.8N	127.4E	VW1-R-10	- -	- -	- - -	- -	- - -	NOT WELL DEFINED
29	192325Z	18.3N	129.2E	56------	1011	15	- - -	- -	- - -	- - - - - - - - - - - - - - -
30	200345Z	18.9N	128.0E	56------	- -	C	- - -	- -	- - -	NO CLOSED CIRCULATION

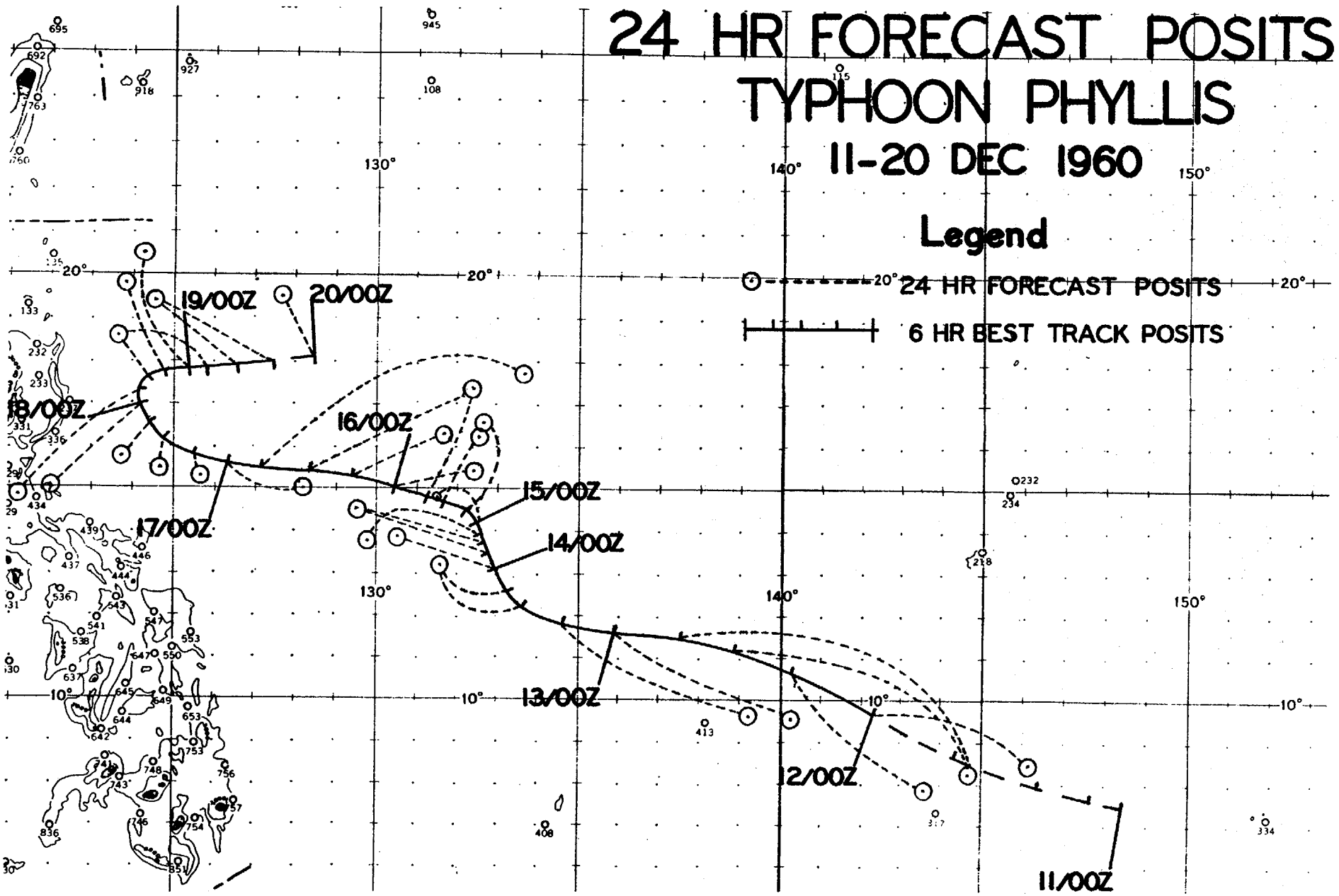
TYPHOON PHYLLIS 11-20 DECEMBER 1960
POSITION AND FORECAST VERIFICATION DATA

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG. DISTANCE	48 HR. ERROR DEG. DISTANCE
110000Z	07.4N	148.3E	- - - -	- - - -
110600Z	07.6N	147.6E	- - - -	- - - -
111200Z	08.0N	146.2E	- - - -	- - - -
111800Z	08.7N	144.2E	- - - -	- - - -
120000Z	09.7N	142.1E	- - - -	- - - -
120600Z	10.7N	140.1E	- - - -	- - - -
121200Z	11.1N	138.9E	- - - -	- - - -
121800Z	11.4N	137.5E	- - - -	- - - -
130000Z	11.6N	135.9E	- - - -	- - - -
130600Z	11.9N	134.5E	116-302	- - - -
131200Z	12.2N	133.7E	294-140	- - - -
131800Z	12.6N	133.2E	292-109	- - - -
140000Z	13.1N	133.0E	289-150	- - - -
140600Z	13.5N	132.9E	287-206	140-205
141200Z	13.8N	132.8E	282-200	322-222
141800Z	14.0N	132.7E	269-159	287-276
150000Z	14.2N	132.6E	293-67	308-304
150600Z	14.6N	132.2E	015-125	317-294
151200Z	14.8N	131.6E	035-102	324-281
151800Z	14.9N	131.1E	037-175	310-179
160000Z	15.0N	130.4E	087-112	013-171
160600Z	15.2N	129.3E	068-165	047-454
161200Z	15.3N	128.2E	070-333	053-480
161800Z	15.4N	127.1E	070-405	057-561
170000Z	15.7N	126.2E	110-117	073-381
170600Z	15.9N	125.4E	161-44	067-464
171200Z	16.2N	124.8E	180-52	066-698
171800Z	16.6N	124.3E	208-64	065-759
180000Z	17.0N	124.1E	226-174	145-148
180600Z	17.3N	124.1E	238-273	225-182
181200Z	17.7N	124.4E	332-80	234-237
181800Z	17.8N	124.8E	336-127	237-264
190000Z	17.8N	125.3E	338-161	241-445
190600Z	17.9N	125.9E	285-127	243-510
191200Z	18.0N	126.6E	309-147	334-219
191800Z	18.1N	127.5E	301-183	347-276

TYPHOON PHYLLIS 11-20 DECEMBER 1960
POSITION AND FORECAST VERIFICATION DATA (CONT'D)

DTG	STORM POSITION LAT.	LONG.	24 HR. ERROR DEG.	DISTANCE	48 HR. ERROR DEG.	DISTANCE
200000Z	18.1N	128.4E	334	92	345	305

AVERAGE 24 HOUR ERROR 157 MI
AVERAGE 48 HOUR ERROR 346 MI


24 HR FORECAST POSITS
TYPHOON PHYLLIS
11-20 DEC 1960
Legend
24 HR FORECAST POSITS
6 HR BEST TRACK POSITS
19/00Z
20/00Z
18/00Z
16/00Z
17/00Z
15/00Z
14/00Z
13/00Z
12/00Z
11/00Z
130°
140°
150°
20°
10°

CHAPTER VI

DESTRUCTIVE EFFECTS OF TYPHOONS

A. General

Of the 19 typhoons and 2 severe tropical storms of 1960, 12 hit heavily populated areas leaving a trail of death and destruction behind them. Reports from the Philippine Islands, the Trust Territory Islands of the U.S., Hong Kong, Ryukyu Islands, Japan, and the Republic of Korea place the total known fatalities at 926. Thousands more were reported missing or injured, and hundreds of thousands of persons were left homeless.

The five typhoons which caused the greatest destruction were: MARY, which struck Hong Kong; SHIRLEY, which struck Taiwan; OLIVE, KIT and LOLA, which struck the Philippines. Information regarding the damage and loss of life caused by each destructive typhoon is presented in the following paragraphs; however, detailed records of the destructive effects of typhoons are not maintained by JTWC. Most of the data regarding damage was obtained from newspaper articles which appeared in the "PACIFIC STARS AND STRIPES" and the "GUAM DAILY NEWS".

In available data, there were no reports of damage by Tropical Storm NADINE or Typhoons FAYE, NINA and PHYLLIS. These cyclones remained over open water and could have caused damage only to shipping and/or isolated islands.

B. KAREN. Area Affected: Philippine Islands.

As KAREN moved across the Philippines, it left at least 56 persons dead and many others missing. Several fishing boats were reported sunk by the typhoon and it was feared that all the fishermen drowned. In one of the hardest hit regions, the central Philippines, all the crops were destroyed and the people, temporarily, faced starvation. At least 7,000 persons were homeless, and the damage to crops and property was estimated at two million dollars.

C. TROPICAL STORM LUCILLE. Areas Affected: Philippine Islands, Peel Island.

Philippine Islands: LUCILLE caused flash floods that killed nearly 300 Filipinos in the Manila area.

Peel Island: Peel Island experienced winds of 50 kts with gusts to 70 kts as T.S. LUCILLE passed the island. At this time the USS Cayuga County was anchored in the harbor which is open to the SW. The harbor possesses a bottle-necked shape, and winds from the SW quadrant undergo an increase in speed due to the "channeling effect" of the terrain. Thus, the harbor area will experience stronger,

but unrepresentative, winds. The Cayuga County experienced winds of 75 kts which caused the ship to broach.

D. MARY. Areas Affected: Hong Kong, Communist China, Taiwan.

Hong Kong: Typhoon MARY, or "Bloody MARY" as it is sometimes called, was the worst typhoon to hit Hong Kong in 23 years. MARY passed through the colony on 8-9 June, and maximum gusts of 105 kts were reported. During one 24 hour period 14.12 inches of rain fell, and damage to roads, homes, public and private facilities, and communication systems was extensive. Two ocean freighters went aground on the Kai Tak airstrip, and another was driven aground on a reef 160 mi SE of Hong Kong.

The strong winds and heavy rains caused hundreds of refugee shacks to collaspe and roads and streets were blocked with fallen trees and debris. Stores and shops were closed, and all public transportation was at a complete standstill. Numerous landslides took the lives of many people. MARY left 18,200 homeless and more than 100 dead, missing, or injured in the refugee crowded colony of Hong Kong. Worst hit were the 300,000 refugees who live in the tin and tarpaper shacks that cling to the rocky hillsides of Hong Kong. Harbor police said that more than 50 fishing vessels capsized and sank in anchorages around Hong Kong at the height of the storm. The only compensation that this typhoon disaster brought to the colony was that MARY's rains brought relief to the local water situation. The reservoirs gained 3 billion gallons of water during the typhoon, which put them at about 2/3 capacity.

Communist China: A dispatch from Communist China stated that the typhoon brought heavy rains and strong winds to the provinces of Fuklein and Kwantung. Dikes and dams were damaged, causing severe flooding, but no figures pertaining to the number of casualties were given. Thousands of people worked night and day reenforcing the dikes against crests of rising waters caused by the typhoon rains. Manpower was also mobilized to gather in the already ripened early rice and other crops.

Taiwan: MARY brought heavy rains to Taiwan, flooding

some of the downtown Taipei areas and damaging some of the rice crops on the S part of the island. The typhoon took the lives of 4 fishermen off the coast of Taiwan, but no fatalities were reported on the island.

E. OLIVE. Areas Affected: Philippine Islands, Hong Kong, Communist China.

Philippine Islands: Passing within 12 miles of Manila, Typhoon OLIVE dumped torrential rains on the city and its suburbs, and partially paralyzed the metropolis of Manila. Many power and telephone lines and advertising signs were blown down in this area, and huge trees were uprooted. However, ample warning gave many residents time to flee to higher ground thus preventing more fatalities. Low-lying areas were flooded by raging rivers and streams that gushed over their banks. During the typhoon virtually all of Manila's roads were impassable and intercoastal shipping was at a standstill. Rainfall at Cubi Point for one 24 hour period during Typhoon OLIVE was 14.96 inches.

OLIVE brought death to 104 persons in the Philippines, and over 500 persons, mostly fishermen, were reported missing. The typhoon left some 60,000 persons homeless in SE Luzon. Reports from the Philippine Government said that over 80 percent of the southern and central Luzon crops, which included coconut trees, rice crops, fishponds, and abaca plantations, were destroyed. Property damage rose to millions of dollars as wide spread destruction of roads, bridges, railroad tracks, and communication lines was reported. The water rose 6 to 8 ft in the low-lying areas of Manila, and a Panamanian freighter and an Italian steamer were reported sunk off the coast of the Bicol Region of southern Luzon.

Hong Kong: No deaths were caused as OLIVE passed S of Hong Kong, but heavy rains flooded the street and did millions of dollars of damage to farmlands.

Communist China: Peiping radio said that Communist Authorities mobilized coastal inhabitants to build dikes and dams against rising waters and to harvest as much rice as possible before the floods and winds destroyed it.

F. POLLY. Areas Affected: Ryukyu Islands, Communist China.

Ryukyu Islands: Okinawa experienced winds of 50 kts and torrential rains as POLLY passed W of the island. The typhoon brought no damage to military installations, and only minor damage was reported to private homes in Okinawan communities. Farmers praised the rain which POLLY brought, because it virtually guaranteed a good rice crop.

Communist China: Peiping radio said that the typhoon brought strong gale to typhoon force winds and torrential rain to parts of the coast. Reports said that a few houses collasped, a quantity of high stalk crops were flattened, and fruit trees suffered some damage.

G. SHIRLEY. Areas Affected: Ryukyu Islands, Taiwan.

Ryukyu Islands: The typhoon took two lives on the island of Miyako Jima.

Taiwan: Typhoon SHIRLEY passed over Taiwan with maximum sustained winds of 125 kts. It passed almost directly over Taipei, but the mountain ranges which encircle the city shielded it from the full force of the typhoon. Torrential rains sent flood waters raging down Taiwan's rivers, forcing thousands of persons to abandon their homes. People in some communities were isolated by the floods.

The typhoon killed 104 people, destroyed or damaged 9,890 houses and left 50,194 homeless in Taiwan. Rail and highway communications were disrupted and 132 fishing boats were damaged. The islands two main hydro-electric power plants at Sun-Moon Lake were put out of commission by landslides. In the Taichung area, 11.8 inches of rain fell during one 12 hour period. The only bright spot in the situation was the fact that the damage to crops was negligible, because almost all of the year's first crop had been harvested before SHIRLEY struck.

H. TRIX. Areas Affected: Ryukyu Islands, Taiwan, Communist China.

Ryukyu Islands: The crew of the U.S. Coast Guard cutter Ironwood will long remember typhoon TRIX as will the crew of the Army seagoing tug which was sent to the cutter's aid. The abrupt and radical shift in TRIX's course out-

witted the Ironwood as well as the weathermen. The ship had sailed SW from Okinawa in an attempt to escape the typhoon, but the abrupt change in TRIX's track placed the ship in the direct path of the typhoon. The weary 50-man crew of the Ironwood battled the 40 ft seas and 140 kt winds without rest or food for 48 hours. TRIX hit the ship with its strongest winds, and the typhoon's eye passed within a few miles of the Ironwood. A mountainous wave crashed over the vessel, flooded the engine room, and shortcircuited the electrical system. Working in total darkness, the crew was able to restore enough power to enable them to start the engines, bring the rudder under control and radio the Army at Naha, Okinawa for help. An Army tug, which was sent to the cutter's rescue, battled heavy seas for 12 hours before reaching the Ironwood. As the two ships headed back for Naha, the tug's overstrained steering system failed. Hasty repairs were made, and the battered ships crept into port together.

TRIX passed within 120 mi of Okinawa. Kadena AB reported heavy rains and winds of 45 kts, but there was no damage to U.S. military installations on the island, however, four Okinawan fishermen were reported missing.

Taiwan: As it moved across northern Taiwan, typhoon TRIX took the lives of 4 persons and left thousands homeless. The typhoon passed about 30 mi N of Taipei and brought heavy rains to the already flooded island of Taiwan. Reports said that 400 homes were destroyed or damaged by flood waters. One hundred and five small trawlers and 6 larger fishing vessels were sunk, and a 1600-ton steamer ran aground. The mountain ranges again sheltered the heavily populated cities of Taiwan, but winds of 55 kts were recorded. Tidal waves whipped up by TRIX swept over several low-lying villages on Taiwan; however, the villages had been evacuated and no casualties were reported. Many breakwaters were washed out by the waves, and thousands of acres of farmland were flooded.

Communist China: Peiping Radio reported heavy damage in Communist China.

I. VIRGINIA. Area Affected: Japan.

As VIRGINIA moved across the island of Shikoku in S Japan, strong winds and heavy rain affected Nagoya, Kobe, and Osaka. Winds of 80 kts were reported on the island of Shikoku, and 2 persons were killed and 1 was injured.

Nearly 4 inches of rain fell on many parts of S Japan. Reports from the National Police Agency of Japan said that the typhoon caused little property damage although some homes were partially destroyed. Instead, farmers welcomed the heavy rains for their scorched fields. By the time VIRGINIA passed over Honshu, it had weakened considerably thereby causing little damage.

J. WENDY. Area Affected: Japan.

Before it reached Japan, Typhoon WENDY had weakened to tropical storm intensity, and thus caused no significant damage.

K. BESS. Area Affected: Japan.

An abrupt recurvature prevented Typhoon BESS from hitting Tokyo. Veering to the NE just before it got to Tokyo Bay, the typhoon passed to the SE of the city and brought almost continuous rain for 24 hours. During a 21 hour period more than 8.5 inches of rain fell at Choshi, on the southeast coast of Japan, but no serious flooding was reported. Wind damage was negligible.

L. CARMEN. Areas Affected: Ryukyu Islands, Korea.

Ryukyu Islands: CARMEN brought winds of gale strength and heavy rains to Okinawa, disrupting communications between Tokyo and Okinawa. Okinawa was in the eye of CARMEN for over 24 hours, and as the storm moved away, heavy rains and strong winds swept the island. Winds of 50 kts were reported, but wind damage was negligible.

Korea: Along the Korean coast CARMEN, created 50 foot waves which submerged 1,500 houses in Pusan, sank one ship, and caused floods which stranded 2,000 persons. The death toll rose to 24, and the property damage caused by the storm was estimated at more than two million dollars.

M. DELLA. Area Affected: Japan.

The typhoon took the lives of 55 persons, the greatest single disaster taking place at Nishinomiya, where a huge landslide trapped 78 workmen who had been constructing a toll road. Of these, only 40 were rescued.

No damage was reported at U.S. military installations in Japan. Most of the damage done by the typhoon was reported on Honshu and Shikoku Islands, where about 350 houses were damaged or destroyed and another 26,000 flooded.

The evacuation of thousands of persons from coastal areas before the storm hit southern Japan kept casualty figures down. Seventeen inches of rain was reported in one town on Shikoku Island, and damage to fields and crops was heavy. Several fishing boats were sunk or washed away, and several sea walls were breached.

N. ELAINE. Area Affected: Taiwan.

ELAINE left at least 5 dead and 3 missing as it roared past and then across Taiwan. A record of 8 inches of rain was dumped on parts of Taiwan, causing floods which knocked out communications, wrecked or damaged at least 280 homes, and isolated whole villages. At the height of these floods some 11,591 persons were driven from their homes or stranded in them.

O. KIT. Areas Affected: Philippine Islands, Communist China.

Philippine Islands: The 80 kt winds of Typhoon KIT brought death and destruction to the Philippines. The greatest damage occurred S of Manila in the Bicol Province. The heavy rains associated with KIT knocked out railroad lines, roads and bridges, and the storm's winds cut off communications and caused two boats to capsize, taking the lives of all 10 persons on board. At least 8 additional small boats and a 240-ton ship capsized in southern Philippine waters, and two other Philippine ships ran aground.

KIT took a total of 149 lives in the Philippines, and an equal number of persons, mostly fishermen whose boats sank in the turbulent seas, were reported missing. Seventy five thousand families were rendered homeless in the central and southern regions of Luzon. The damage to crops, public works, communications, and public and private property was estimated at three million dollars. Damage to crops was particularly heavy because the typhoon struck at the height of the rice harvesting season.

Communist China: A Communist Chinese news broadcast reported that the typhoon caused widespread loss of rice crops on the Chinese mainland. Radio Peiping also reported that two thirds of the 250,000 acres of rice on Hainan Island and 25,000 acres of rice on Luichow Peninsula were flattened.

P. LOLA. Area Affected: Philippine Islands.

As LOLA approached the Philippines, the associated strong winds and heavy seas caused a fishing vessel to sink, and 19 of its 20-man crew were lost. LOLA was the second typhoon to hit central Luzon in a week. Much of Manila was under 3 ft of water, and rising flood waters threatened to break a dike N of Manila and bring about more destruction. Fifty-eight persons were reported killed during the typhoon, and heavy damage was reported to highways, rail lines, and communications and utilities systems. Because of the breakdowns in the transportation systems, many villages and towns would have faced starvation had they not received food supplies quickly. Fortunately, government and volunteer relief workers rushed food supplies to these stricken communities. The rice crops, already heavily damaged by Typhoon KIT, suffered additional severe losses. Damage to property and crops was estimated at 15 million dollars.

Q. MAMIE. Areas Affected: Iwo Jima, Japan.

Iwo Jima: MAMIE brought wind gusts of 90 kts to the island of Iwo Jima, but the amount of damage, if any, is not known.

Japan: As it passed SE of Tokyo, winds of 70 kts were recorded at the island of Hachijo Jima. Powerful gusts whipped tiles off roofs on the island of Oshima in the mouth of Tokyo Bay, and churned up waves 18 to 20 ft high.

R. OPHELIA. Area Affected: Caroline Islands.

As it passed over Ulithi, Typhoon OPHELIA killed 2 children, injured 4 other persons, and severely damaged all buildings except the concrete U.S. Coast Guard Loran Station and a church. Winds in excess of 125 kts were experienced, and the atoll was covered by two ft of water. The airfield at Falalop was flooded and covered with debris, as was the rest of the island. Two ships were immediately sent to Ulithi with emergency rations and medical supplies for all of the island's inhabitants.

This typhoon is the second named OPHELIA to cause devastation and suffering on Ulithi. Typhoon OPHELIA of 16 January 1958 was even more destructive.

For damage caused by OPHELIA (1960) on Ulithi, see following page.

CHAPTER VII

RESEARCH

A. GENERAL

Research related to tropical cyclones is limited due to lack of personnel and time. Once the typhoon season is over, usually in December, the "Annual Typhoon Report" is written and published. This is completed by 1 April, and parts of April, May, and June are devoted to research. Problems encountered during the typhoon season are always greater in number than those solved during the research period. Research may be divided into two types: that leading to simplification of the forecast problem, and that research designed to improve the forecast. Projects are listed and discussed in this chapter.

B. A TEST OF THE MILLER-MOORE METHOD OF FORECASTING HURRICANE MOVEMENT AS APPLIED TO PACIFIC TYPHOONS OF 1960

While it is generally agreed that the motion of a typhoon or hurricane is not determined by the characteristics of the circulation at any one level, a number of objective forecasting methods have used this approach for sake of simplicity and useability.

One of the more recent studies of this type was made by B.I. Miller and P.L. Moore of the U.S. Weather Bureau and published in the February 1960 issue of the "Bulletin of the American Meteorological Society".

Briefly, the method consisted of correlating the storm movement with a mean geostrophic wind and the past 12 hour storm movement. Somewhat surprisingly this method, based upon 18 hurricanes and 127 forecast cases, showed better results using 700 mb data than either 500 or 300 mb data.

The method involves separate determination of meridional and zonal forecasts of storm movement. The equations developed by Miller-Moore are:

Initial latitude equal to or less than 27.5^{o}

$$\overline{V} = 0.23v_7 + 0.65Py + 2.3$$
$$\overline{U} = 0.42u_7 + 0.54Px - 2.4 \qquad (1)$$

Initial latitude more than 27.5^{o}

$$\overline{V} = 0.71v_7 + 0.40Py + 3.0$$
$$\overline{U} = 0.61u_7 + 0.48Px - 3.8 \qquad (2)$$

$\overline{U}$ = forecast mean 24 hour zonal speed of center movement (kts)

$\overline{V}$ = forecast mean 24 hour meridional speed of center movement (kts)

v_7 = first approximation: mean 700 mb geostrophic wind between five pairs of points 7.5 degrees E and 7.5 degrees W of the storm center and extending from 5 degrees S to 5 degrees N of the center. If southward movement results - no further computation.

second approximation: add points 7.5 degrees N of center to first calculation. If both of the first

two approximations are less than 6.5 kts, use the largest - no further computation.

third approximation: same as second but adding points 10 degrees N of center to second approximation. Use the largest of the three approximations.

u_7 = mean 700 mb geostrophic wind between seven pairs of points 5 degrees S of the initial position of the storm center and 5 degrees N of the latitude the $\overline{V}$ computation indicates the center will reach 12 hours after chart time.

Py = mean meridional speed of movement of center for the 12 hours prior to chart time (kts).

Px = mean zonal speed of movement of center for the 12 hours prior to chart time (kts).

u_7 and v_7 are computed from the latest 700 mb chart on the Miller-Moore Grid shown herein. Heights are tabulated for every 2½ degrees. In the case of the meridional component, the average height difference is computed between 5 degrees N and S of the center; however, depending upon the resulting northward speed of the storm, this grid may be extended to 7½ or 10 degrees N of the center in accordance with the specified criteria. In the case of the zonal component, the average height difference between the two horizontal rows is computed; the bottom row being 5 degrees S of the initial surface position of the storm and the top row being 5 degrees N of the 12 hour meridional forecast position of the center. The average meridional and zonal height differences are then reduced to meters per degree and converted to geostrophic wind for the central latitude using the graph shown herein. $\overline{U}$ and $\overline{V}$ are then solved for, using the equations (1) or (2).

The above method was tested at the conclusion of the 1960 Typhoon Season, and the 24 hour forecast errors are shown on two scatter diagrams in this Section. Forecasts were made on Typhoons OLIVE through PHYLLIS. There were 29 cases N of 27.5 degrees N and 173 cases at or S of 27.5 degrees N. The cases used were based on forecasts made whenever the circulation was of tropical storm or typhoon intensity. The best tracks (shown in Chapter V) were used to obtain the data for Px and Py. The meridional and zonal 24 hour forecasts were applied to the best track position, and the error thus obtained is the difference between the 24 hour forecast position and the corresponding best track position.

The scatter diagram for cases N of 27.5 degrees N has little significance because the errors appear to be fairly well distributed; probably due to the limited number of cases available. In the scatter diagram for cases at or S of 27.5 degrees N, the majority of the cases are in the northeast quadrant. This indicates that the Miller-Moore method can be corrected to better distribute the forecast error; however, this assumption is based on data for one year, which includes many unusual tracks. The Miller-Moore method will be further evaluated on the data available for 1959, which was a season with more normal typhoon tracks and on the data that becomes available during 1961.

Tables in this Section show the 24 hour Miller-Moore forecast errors for Typhoons OLIVE through PHYLLIS. The distance, and meridional and zonal forecast errors are in nautical miles. The distance error is the difference between the forecast position and the actual position of the circulation. The meridional and zonal forecast error is the distance the forecast position is N,E,S, or W of the actual position of the circulation. The average distance error of all forecasts was 138 mi.

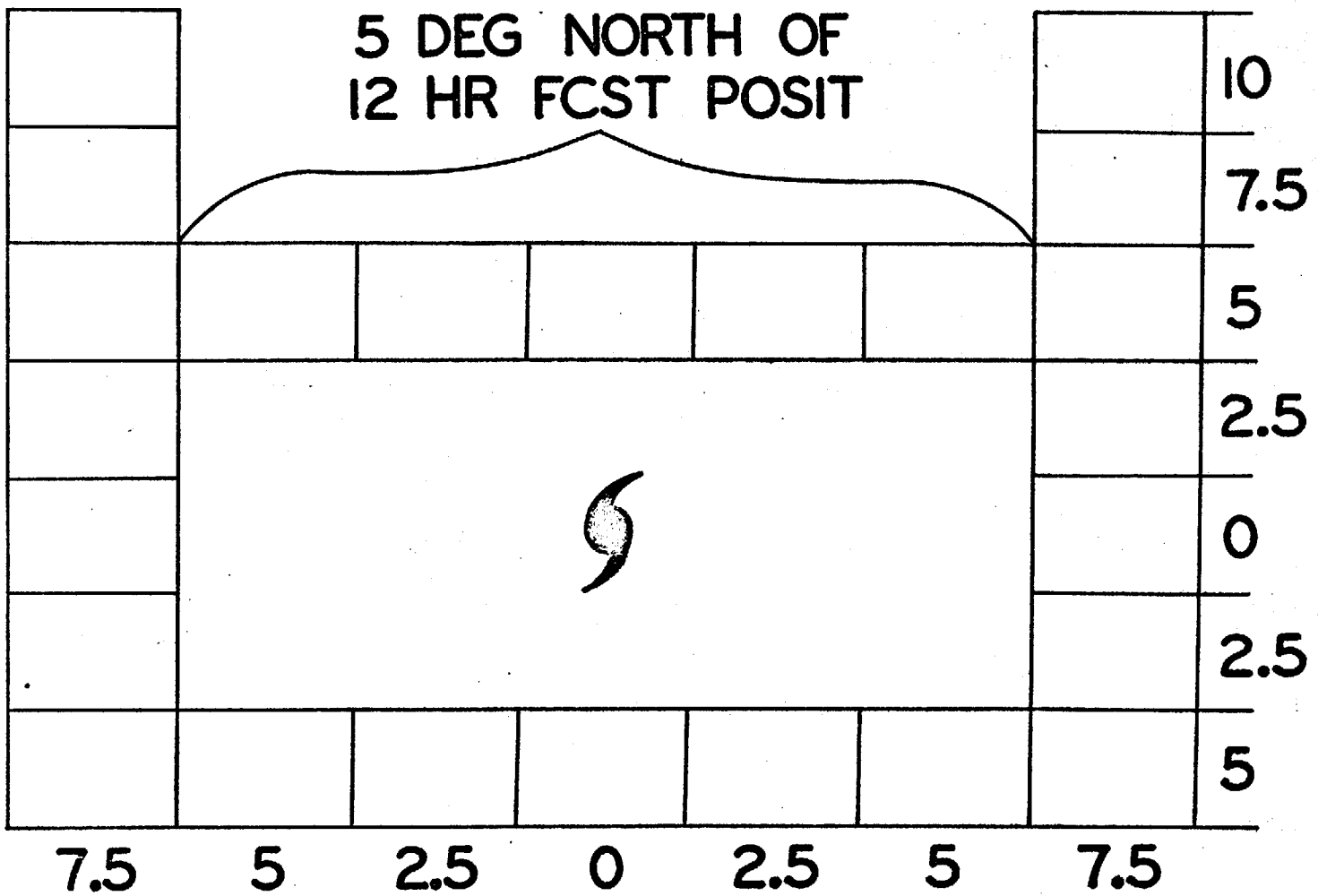
It should be emphasized that the Miller-Moore forecasts, as presented herein, cannot be compared with the operational forecasts made by the JTWC for the following reasons:

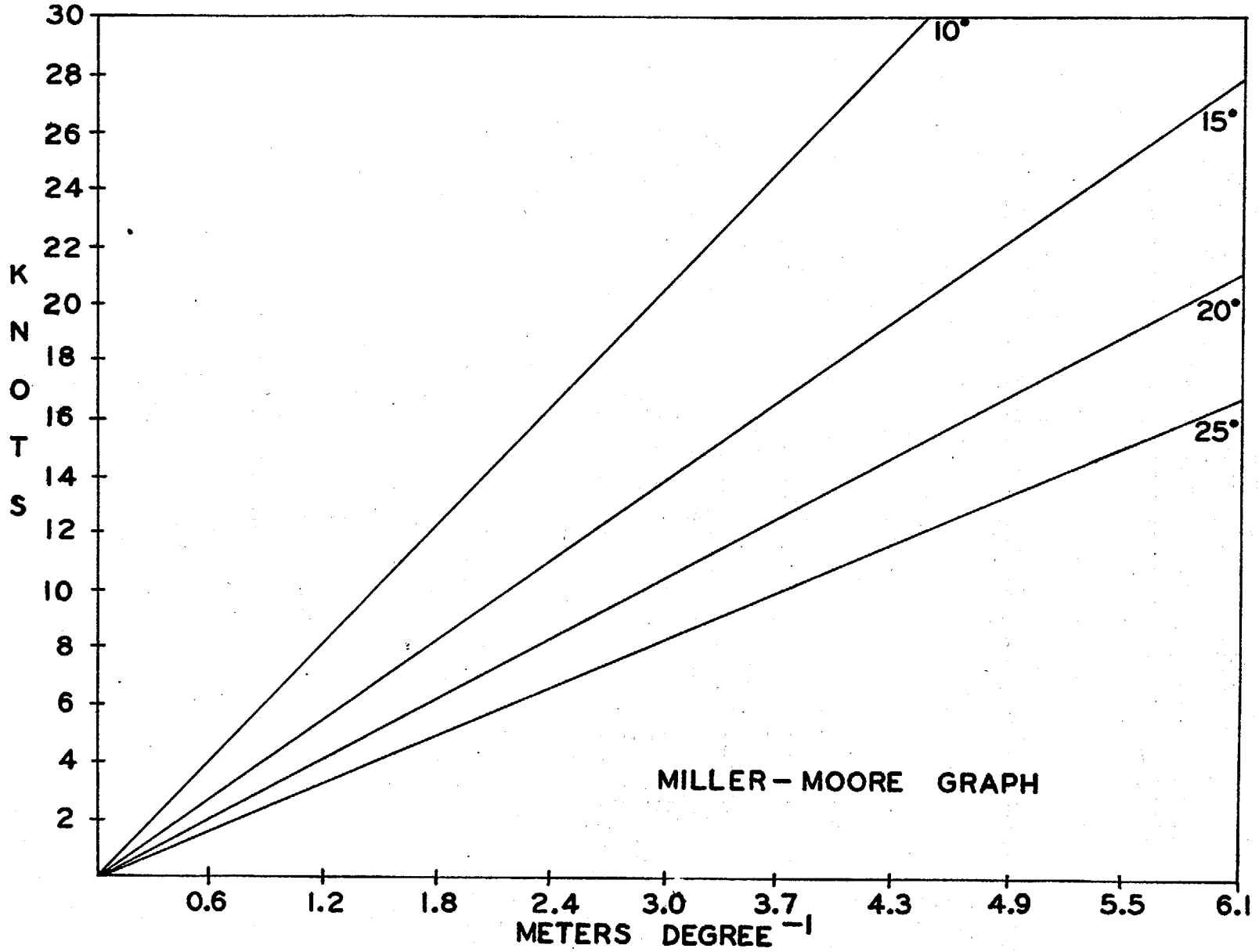
(1) JTWC forecasts are issued every 6 hours. Seven hundred millibar data, the bases for the Miller-Moore forecasts, are available in the Pacific only every 12 hours.

(2) The JTWC 24 hour forecasts are valid for a full 24 hours from the time they are transmitted. These forecasts are therefore often based on surface data as much as 6 hours old, and upper air data as much as 12 hours old. Due to the time required to process and analyze the 700 mb data, Miller-Moore forecasts are valid for a period of less than 20 hours from the time of preparation.

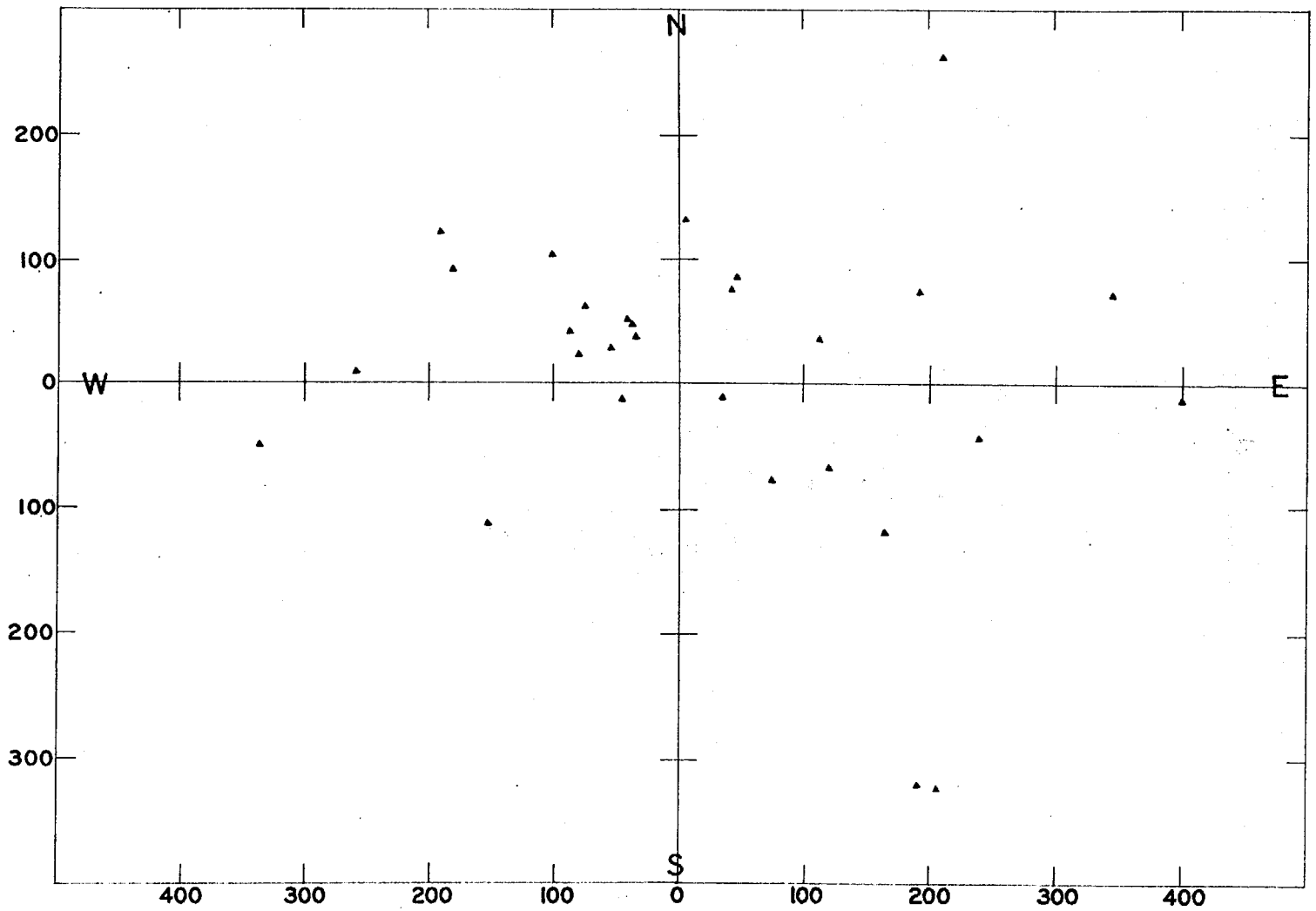
(3) In this evaluation the Miller-Moore Px and Py (past 12 hour movement factors) were obtained from best tracks. The JTWC forecasts were of course prepared from the best known positions of the typhoon or tropical storm at the time the forecasts (warnings) were prepared.

MILLER-MOORE GRID

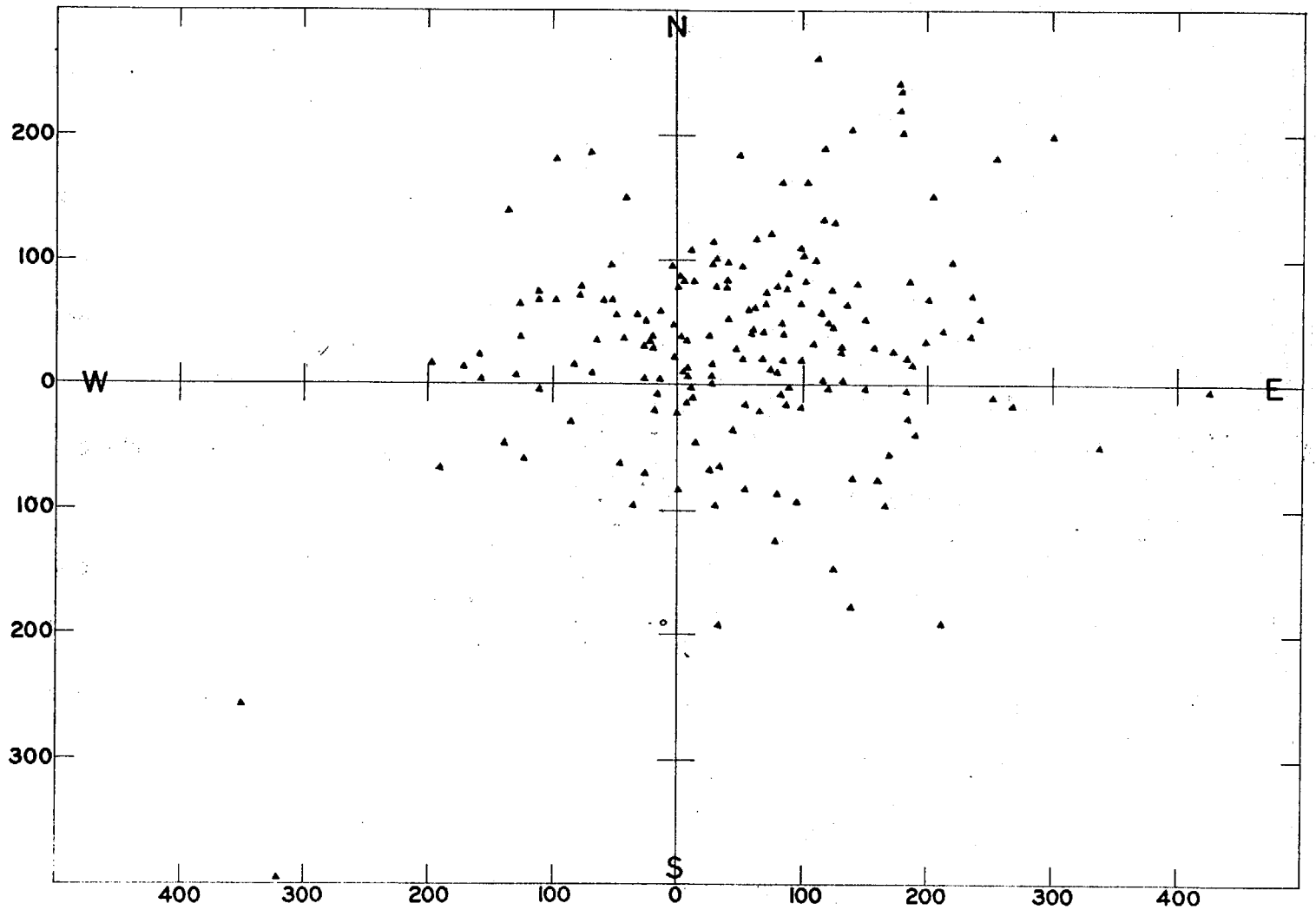



30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
KNOTS
10°
15°
20°
25°
MILLER – MOORE GRAPH
0.6
1.2
1.8
2.4
3.0
3.7
4.3
4.9
5.5
6.1
METERS DEGREE⁻¹

MILLER-MOORE 24 HOUR FORECAST ERRORS
NORTH OF 27.5°N



MILLER-MOORE 24 HOUR FORECAST ERRORS
AT OR SOUTH OF 27.5° N



MILLER-MOORE 24 HOUR FORECAST ERRORS

OLIVE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2500Z	88	67	-	-	57
2512Z	103	50	-	85	-
2600Z	124	68	-	-	110
2612Z	48	39	-	26	-
2700Z	72	22	-	69	-
2712Z	75	45	-	62	-
2800Z	90	-	15	88	-
2812Z	82	10	-	80	-
2900Z	133	84	-	105	-
2912Z	146	100	-	113	-
3000Z	146	104	-	102	-
Average	101				

POLLY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1900Z	55	52	-	-	24
1912Z	40	36	-	-	22
2000Z	44	39	-	-	19
2012Z	49	49	-	-	1
2100Z	20	15	-	10	-
2112Z	85	-	6	84	-
2200Z	98	42	-	87	-
2212Z	89	79	-	41	-
2300Z	74	44	-	61	-
2312Z	85	79	-	32	-
2400Z	101	97	-	29	-
2412Z	12	-	2	11	-
2500Z	134	3	-	133	-
2512Z	100	21	-	99	-

MILLER-MOORE 24 HOUR FORECAST ERRORS

POLLY (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2600Z	28	1	-	28	-
2612Z	15	5	-	-	14
2700Z	16	-	14	8	-
2712Z	71	-	19	66	-
2800Z	140	-	67	119	-
2812Z	111	-	76	74	-
2900Z	51	38	-	-	35
Average	68				

SHIRLEY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
3012Z	83	84	-	6	-
3100Z	36	17	-	29	-
3112Z	40	35	-	8	-
0100Z	126	90	-	90	-
0112Z	87	62	-	58	-
0200Z	149	-	46	-	139
0212Z	102	-	95	32	-
0512Z	373	-	320	192	-
0600Z	197	-	113	-	152
Average	133				

TRIX

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0512Z	74	36	-	-	63

MILLER-MOORE 24 HOUR FORECAST ERRORS

TRIX (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0600Z	26	-	20	-	17
0612Z	72	-	65	34	-
0700Z	122	-	2	122	-
0712Z	162	53	-	152	-
0800Z	192	185	-	52	-
0812Z	248	205	-	141	-
0900Z	192	140	-	-	134
0912Z	76	58	-	-	47
1000Z	188	-	25	187	-
Average	135				

VIRGINIA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0912Z	47	-	45	15	-
1000Z	251	-	192	217	-
1012Z	178	-	56	171	-
1100Z	103	86	-	46	-
1112Z	148	103	-	-	102
1200Z	255	-	43	240	-
Average	164				

WENDY

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1200Z	200	-	97	168	-

MILLER-MOORE 24 HOUR FORECAST ERRORS

WENDY (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1212Z	59	47	-	-	37
1300Z	133	37	-	112	-
Average	131				

BESS

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1800Z	162	30	-	159	-
1812Z	190	16	-	190	-
1900Z	91	68	-	-	51
1912Z	105	-	96	-	34
2000Z	60	51	-	-	40
2012Z	226	122	-	-	190
2100Z	264	59	-	-	258
2112Z	205	93	-	-	183
2300Z	90	62	-	-	76
2312Z	356	72	-	346	-
2400Z	401	-	12	400	-
2412Z	210	74	-	193	-
Average	197				

CARMEN

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1800Z	102	74	-	73	-
1812Z	108	99	-	47	-
1900Z	105	108	-	14	-
1912Z	65	58	-	-	30

MILLER-MOORE 24 HOUR FORECAST ERRORS

CARMEN (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2000Z	75	-	62	-	46
2012Z	88	20	-	86	-
2100Z	119	34	-	111	-
2112Z	201	35	-	200	-
2200Z	137	-	93	97	-
2212Z	192	-	149	126	-
2300Z	201	-	119	164	-
2312Z	330	-	323	207	-
Average	144				

DELLA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1900Z	240	98	-	222	-
2200Z	230	44	-	215	-
2212Z	60	22	-	54	-
2300Z	146	110	-	100	-
2312Z	191	163	-	106	-
2400Z	157	148	-	-	42
2412Z	11	11	-	6	-
2500Z	56	29	-	48	-
2512Z	136	47	-	125	-
2600Z	176	19	-	185	-
2612Z	184	27	-	175	-
2700Z	96	-	2	90	-
2712Z	57	-	15	55	-
2800Z	22	22	-	-	2
2812Z	133	131	-	5	-
2900Z	89	76	-	42	-
2912Z	47	-	12	-	45
Average	119				

MILLER-MOORE 24 HOUR FORECAST ERRORS

ELAINE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2112Z	138	27	-	132	-
2200Z	117	4	-	116	-
2212Z	137	30	-	133	-
2300Z	252	-	66	-	240
2312Z	421	199	-	302	-
2400Z	294	236	-	180	-
2412Z	75	-	67	28	-
2500Z	155	65	-	138	-
Average	199				

FAYE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2400Z	40	33	-	-	25
2412Z	197	83	-	183	-
2500Z	133	50	-	122	-
2512Z	180	133	-	118	-
2600Z	222	190	-	119	-
2612Z	310	183	-	256	-
2700Z	273	202	-	183	-
2712Z	258	153	-	206	-
2800Z	193	-	40	193	-
2812Z	100	-	17	98	-
2900Z	154	-	74	140	-
2912Z	97	-	82	56	-
3000Z	12	-	12	-	-
3012Z	70	-	70	-	25
3100Z	36	-	10	36	-
3112Z	90	41	-	-	87
Average	148				

MILLER-MOORE 24 HOUR FORECAST ERRORS

KIT

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
0512Z	86	17	-	-	82
0600Z	38	38	-	3	-
0612Z	171	15	-	-	170
0700Z	68	10	-	-	67
0712Z	154	5	-	-	156
0800Z	110	-	4	-	110
0812Z	76	13	-	75	-
0900Z	176	-	76	161	-
0912Z	245	38	-	237	-
1000Z	120	115	-	30	-
1012Z	33	30	-	-	18
1100Z	94	65	-	72	-
1112Z	117	118	-	65	-
1200Z	150	122	-	76	-
1212Z	92	95	-	52	-
1300Z	109	80	-	81	-
Average	115				

LOLA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1000Z	197	186	-	-	68
1012Z	205	181	-	-	97
1100Z	180	163	-	85	-
1112Z	284	220	-	180	-
1200Z	114	77	-	88	-
1212Z	149	-	125	80	-
1300Z	270	-	15	270	-
1312Z	255	-	10	255	-
1400Z	183	82	-	145	-
1412Z	22	-	22	-	-

MILLER-MOORE 24 HOUR FORECAST ERRORS

LOLA (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1500Z	252	54	-	245	-
1512Z	188	136	-	127	-
1600Z	12	7	-	9	-
1612Z	28	6	-	28	-
1700Z	131	58	-	117	-
Average	165				

MAMIE

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1512Z	60	-	35	45	-
1600Z	17	-	7	-	15
1612Z	107	100	-	32	-
1700Z	84	62	-	62	-
1712Z	110	96	-	-	52
1800Z	112	79	-	-	76
1812Z	25	5	-	-	25
1900Z	83	-	83	-	-
1912Z	97	-	193	34	-
2000Z	221	-	178	140	-
2012Z	58	29	-	-	54
2100Z	89	23	-	-	80
Average	89				

NINA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2500Z	85	42	-	70	-

MILLER-MOORE 24 HOUR FORECAST ERRORS

NINA (CONT'D)

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2512Z	65	54	-	42	-
2600Z	90	84	-	41	-
2612Z	297	243	-	179	-
2700Z	282	263	-	113	-
2712Z	340	262	-	212	-
Average	193				

OPHELIA

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
2800Z	119	68	-	-	97
2812Z	114	65	-	100	-
2900Z	137	75	-	-	110
2912Z	343	-	50	341	-
3000Z	427	-	5	427	-
0100Z	118	-	87	81	-
0112Z	137	-	58	-	121
0200Z	89	-	29	-	85
0212Z	198	23	-	-	196
0300Z	107	78	-	-	76
0312Z	151	-	3	151	-
0400Z	184	-	5	184	-
0412Z	83	60	-	-	62
0500Z	422	-	256	-	349
0512Z	500	-	395	-	320
0600Z	340	-	50	-	335
Average	217				

MILLER-MOORE 24 HOUR FORECAST ERRORS

PHYLLIS

VERIFYING TIME	DISTANCE ERROR	MERIDIONAL ERROR N	MERIDIONAL ERROR S	ZONAL ERROR E	ZONAL ERROR W
1400Z	126	9	-	-	128
1412Z	131	40	-	-	123
1500Z	74	74	-	2	-
1512Z	88	87	-	2	-
1600Z	147	77	-	125	-
1612Z	216	70	-	203	-
1700Z	243	71	-	238	-
1712Z	15	-	10	13	-
1800Z	53	38	-	-	42
1900Z	65	65	-	-	125
1912Z	95	95	-	-	3
2000Z	83	83	-	15	-
Average	111				

AVERAGE 24 HOUR DISTANCE ERROR 138 MI (OLIVE-PHYLLIS)

C. WACHHOLZ GRAPHS

These graphs were compiled by Captain Edward R. Wachholz, USAF, in April and May of 1960 after a season of forecasting typhoons in 1959 at FWC/JTWC. The graphs are compiled from reconnaissance data for 1957, 1958, and 1959, and were tested on 1956 data. The three years used provided more complete information than any other period due to the availability of flight level winds determined by the APN-82, Doppler wind measuring equipment.

The first chart, called a coordination chart, is based on the theory that all typhoons develop in homogeneous air over areas of similar characteristics, and that typhoons are similar thermodynamically except for differences in intensity. These variations of intensity are due to seasonal heat differences, differences in spawning areas, and geography.

The graphs are as follows:

(1) The first graph (see this chapter) relates minimum 700 mb height (ft), maximum 700 mb temperature (^{o}C), and minimum surface pressure (mb), as modified by latitude, to maximum 700 mb wind speed (kts) and maximum surface wind (kts). The graph is based on the following formulas:

$$\text{Sfc wind max} = \left[17 + \left(\frac{\theta - 15}{5}\right)\right]\sqrt{372 - \frac{7hm}{28}} \qquad (1)$$

$$\text{700 mb wind max} = 50 + \left(.5 + \frac{Sfcm}{500}\right)(Sfcm - 50) \qquad (2)$$

θ represents the latitude of the typhoon eye
7hm is the 700 mb minimum height of the eye in ft
Sfcm is the surface wind max around the eye in kts

The basis of these formulas is the original formula by Dr. Robert Fletcher who is presently Director of Scientific Services, Air Weather Service. This formula is shown below:

$$\text{Sfc wind max} = 16\sqrt{1010 - P_c} \qquad (3)$$

1010 represents the pressure in mb at the "bar" of the typhoon, and may be adjusted if the "bar" pressure differs.

P_C is the center pressure of the typhoon or hurricane in mb.

Note on the coordination chart that the 700 mb-surface wind relationship is direct (they are the same at 50 and 250 kts only), and that the surface pressure-700 mb height is also directly related. When the surface pressure is known, find it on the graph then follow horizontally to the correct latitude; from there extend vertically to the surface wind or to the 700 mb wind.

This chart was used through the 1960 season and found to be quite reliable. Information most frequently used to determine the surface wind was the 700 mb height and the 700 mb wind which are accurately measured by the aircraft. The surface pressure was most frequently obtained from dropsonde equipment and available as raw uncorrected data at time of chart use. Its value varied at times from the corrected pressure available later. The 700 mb temperature parameter was found to be least useful due to the fact that it is reported in whole degrees, and a small variation in temperature represents a large variation of other features in the graph. This graph works only for circulations thermodynamically classified as typhoons. The coordination graph is also used as an overlay for the climatological graphs discussed below.

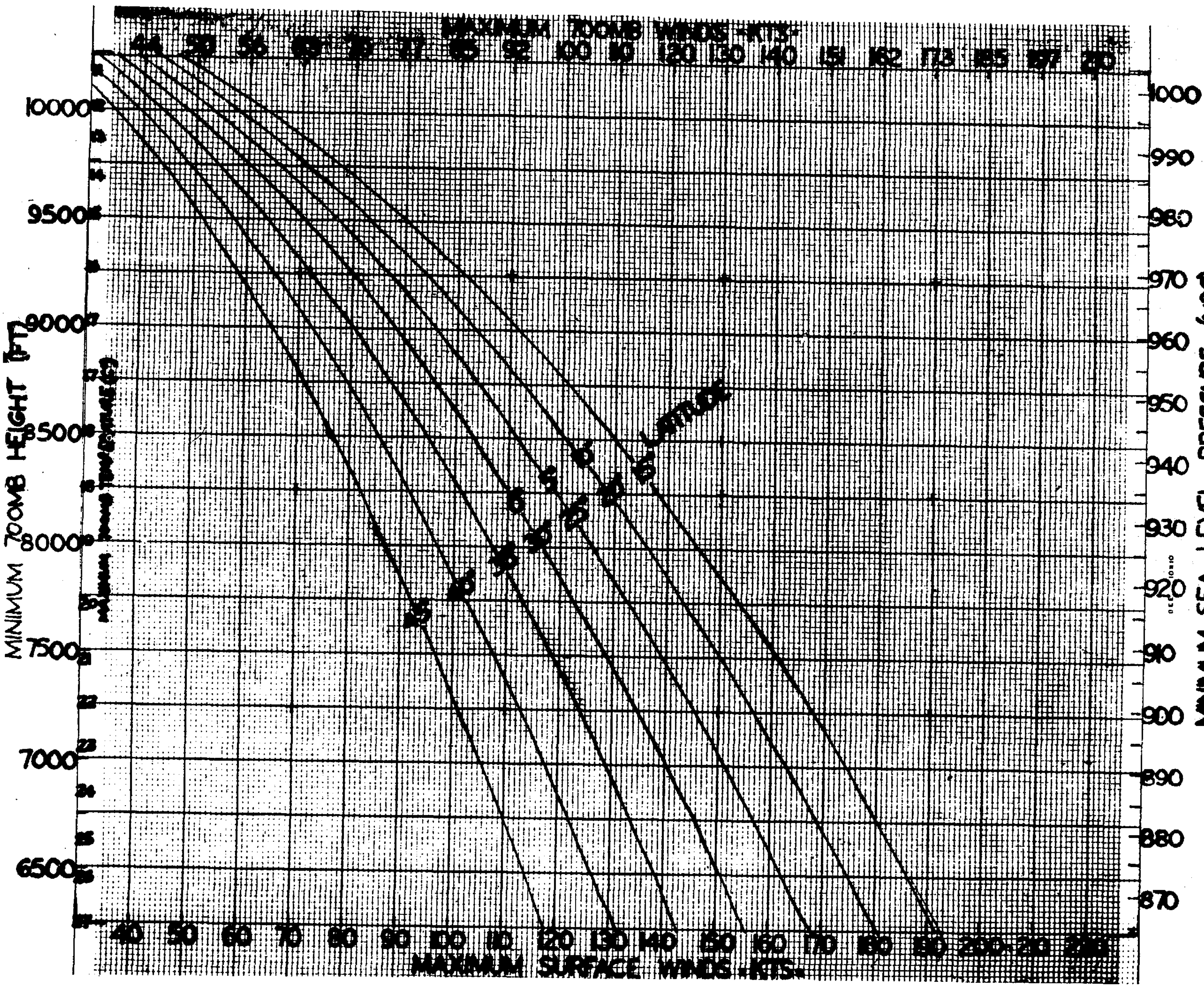
(2) Three graphs of typhoon track climatology, using time and the 700 mb height as ordinates, are shown herein. The charts are for the periods June-15 August, 15 August-December, and November-May, for the western North Pacific and the South China Sea only. These graphs are scaled to the height values of the coordination graph. The time varies horizontally and the space between two vertical lines represents 6 hours. These graphs are "folded" at A and A'. There is an upper, lower and median line for each graph. Heavy hatching is placed between the upper and lower limits. Behavior of typhoons of various source regions is indicated on the graphs. The upper limit line on the June-15 August graph for the folded part beginning with A' starts 18-24 hours after A'. This is because those circulations that are weak(have height values that are near 10000 ft) usually do not re-intensify. For this reason, no upper limit is drawn in for the second intensification part of the graph.

The June-15 August trace is 7 days in length and the other traces are 9½ to 10 days long. The double minimums on the June-15 August, November-May charts represent weakening, and re-intensification as a result of passage over land, or through the ridge line. The midseason 15

August-December trace reflects some of this variation between the 12-18 hour period after A'.

These charts are useful aids in forecasting typhoon intensity trends, but may not be used to forecast recurvature, minimum height/pressure, lifetime of the typhoon, or other implied features. To clarify the climatological aspect, the typhoons (including T.S. LUCILLE and NADINE) of this season averaged 7 days 17 hours, from first to last warning, comparing favorably with the climatology of the 3 charts. The life of two typhoons were 2½ and 15 3/4 days respectively; neither the 2½ day nor the 15 3/4 day typhoon would fit these charts due to the time difference, even though the curves would be similar; however, variation of intensity could be forecast reasonably for each.

In summation, these graphs were used during the 1960 typhoon season and found to be very successful operational tools.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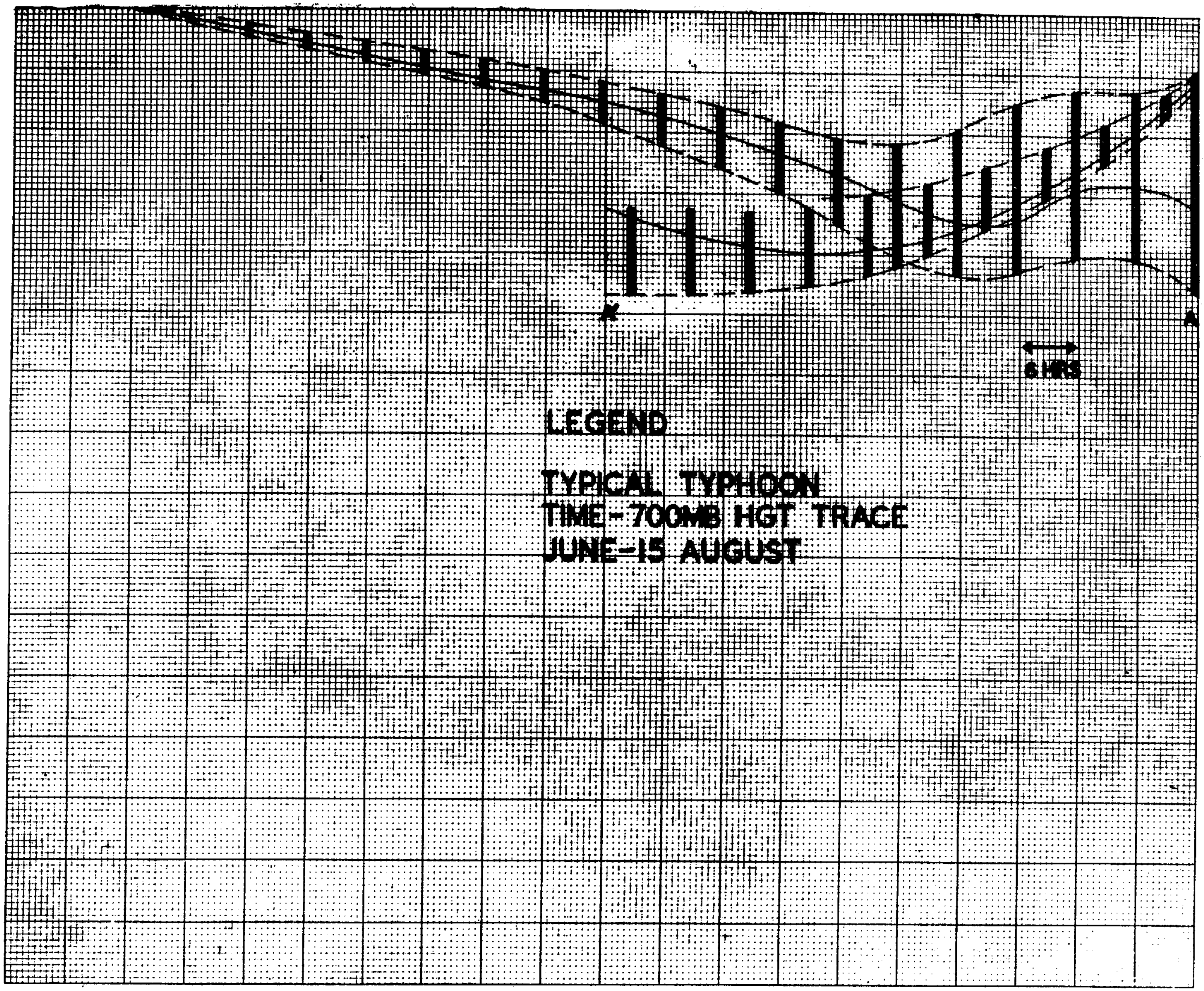
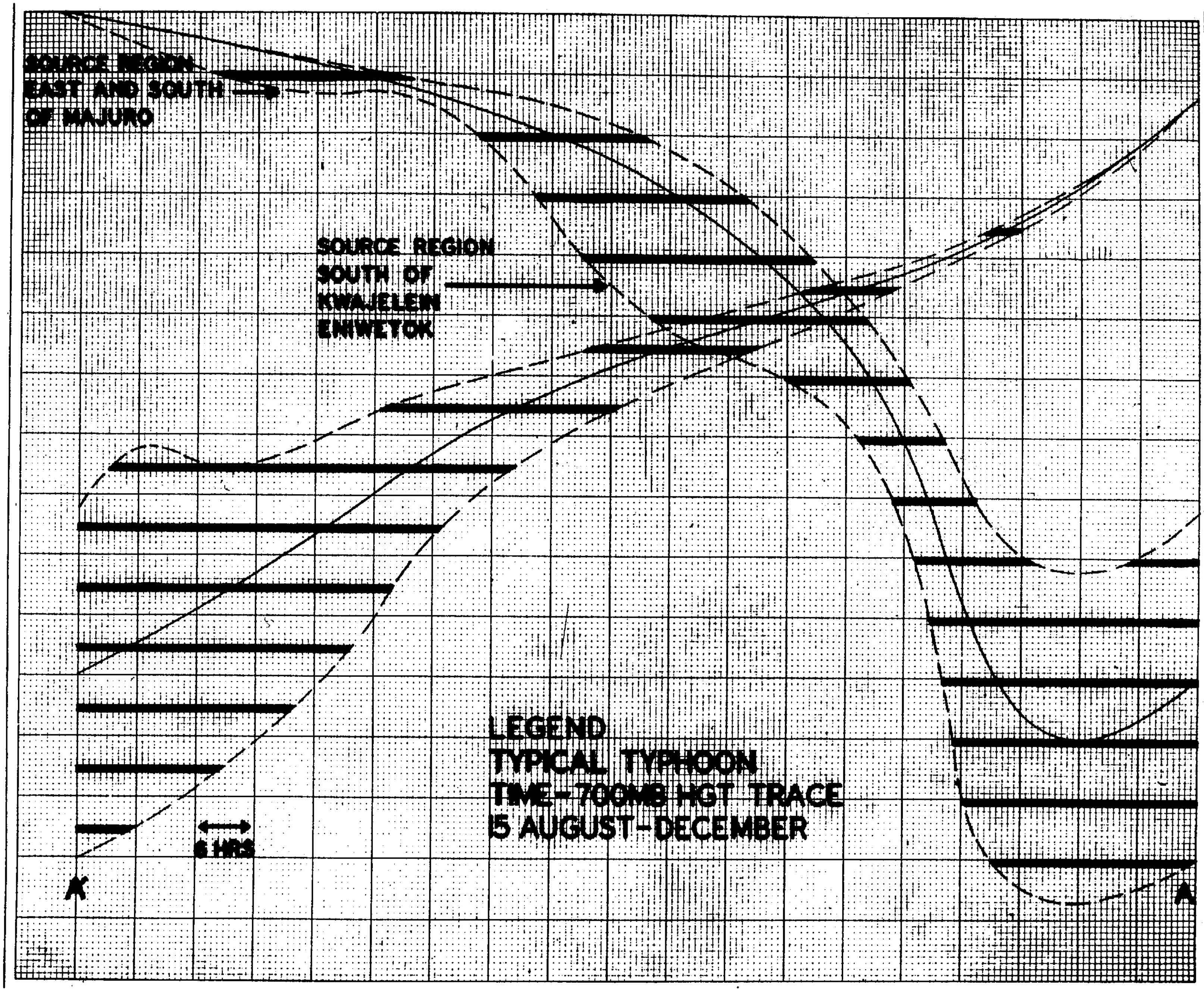
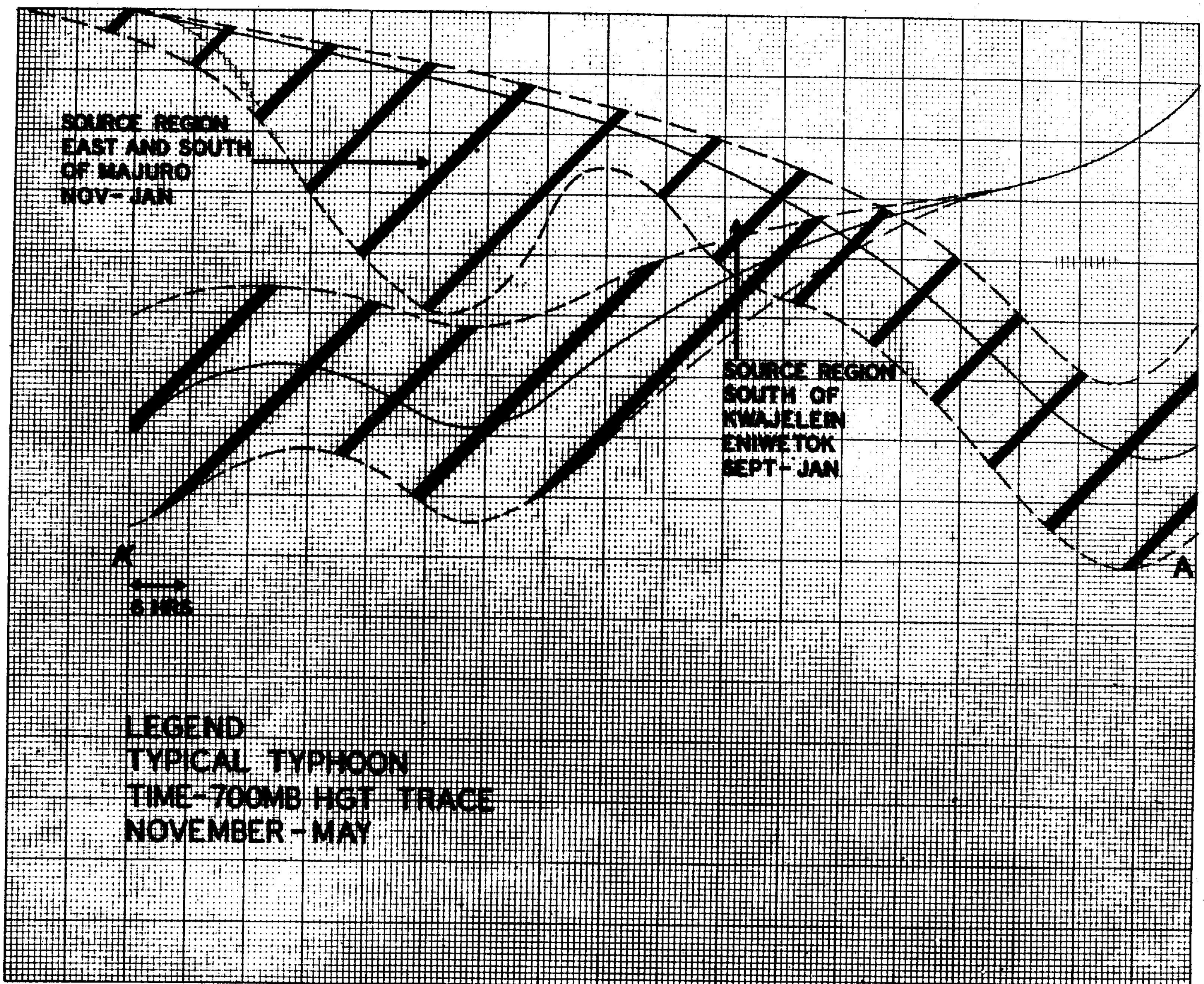
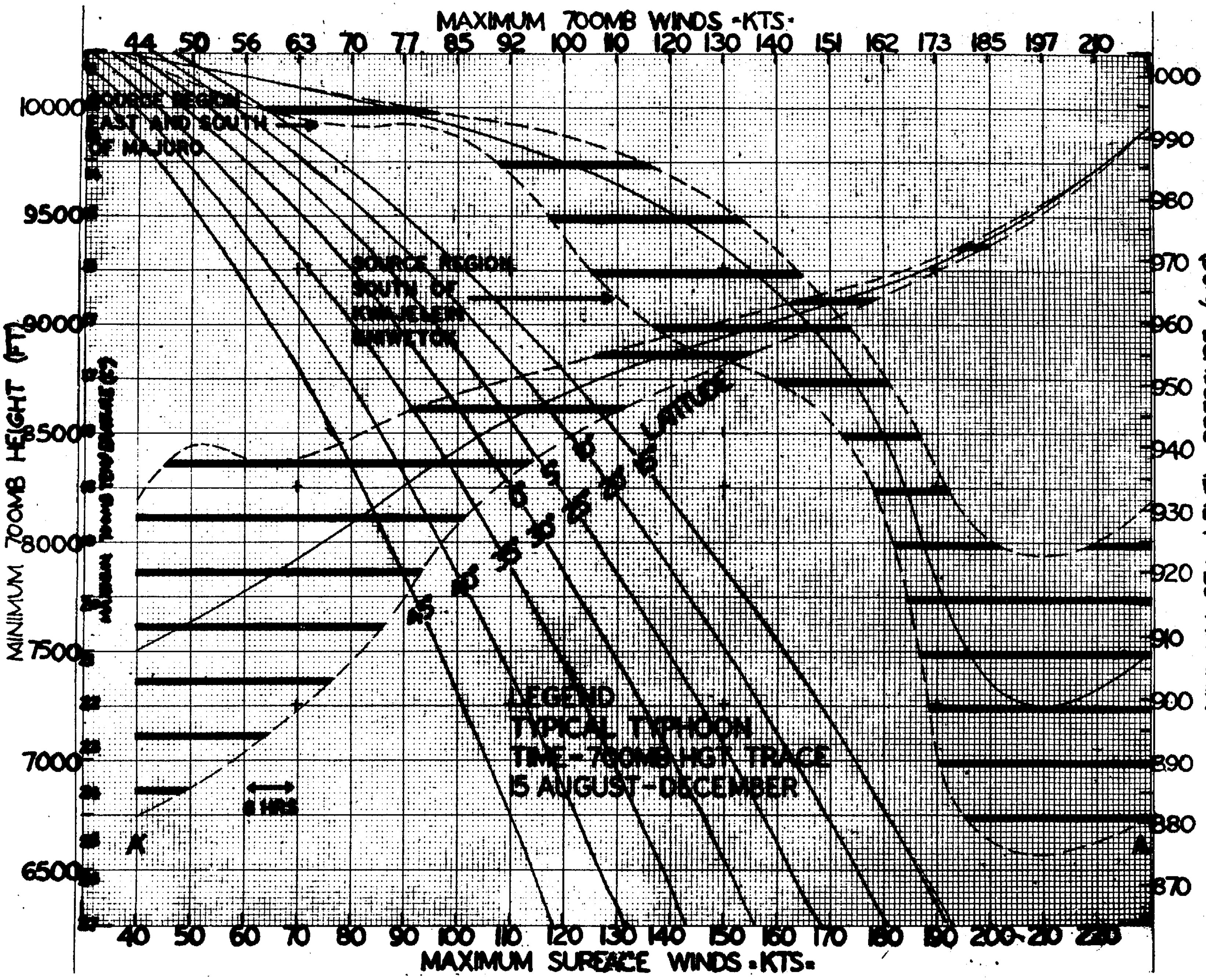
44 50 56 63 70 77 85 92 100 110 120 130 140 151 162 173 185 197 210
MINIMUM 700MB HEIGHT (FT)
10000
9500
9000
8500
8000
7500
7000
6500
MINIMUM SEA LEVEL PRESSURE (MBS)
1000
990
980
970
960
950
940
930
920
910
900
890
880
870
LATITUDE
40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220
MAXIMUM SURFACE WINDS -KTS-


A
A
6 HRS
LEGEND
TYPICAL TYPHOON
TIME-700MB HGT TRACE
JUNE-15 AUGUST


SOURCE REGION
EAST AND SOUTH
OF MAJURO
SOURCE REGION
SOUTH OF
KWAJELEIN
ENIWETOK
LEGEND
TYPICAL TYPHOON
TIME-700MB HGT TRACE
15 AUGUST-DECEMBER
6 HRS
A'
A


SOURCE REGION
EAST AND SOUTH
OF MAJURO
NOV-JAN
SOURCE REGION
SOUTH OF
KWAJELEIN
ENIWETOK
SEPT-JAN
A
A
6 HRS.
LEGEND
TYPICAL TYPHOON
TIME-700MB HGT TRACE
NOVEMBER-MAY


MAXIMUM 700MB WINDS -KTS-
44 50 56 63 70 77 85 92 100 110 120 130 140 151 162 173 185 197 210
SOURCE REGION
EAST AND SOUTH
OF MAJURO
SOURCE REGION
SOUTH OF
KWAJELEIN
ENIWETOK
LATITUDE
10 15 20 25 30 35 40 45
LEGEND
TYPICAL TYPHOON
TIME - 700MB HGT TRACE
15 AUGUST - DECEMBER
6 HRS
MINIMUM 700MB HEIGHT (FT)
10000 9500 9000 8500 8000 7500 7000 6500
MINIMUM SEA LEVEL PRESSURE (MBS)
1000 990 980 970 960 950 940 930 920 910 900 890 880 870
40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220
MAXIMUM SURFACE WINDS -KTS-

APPENDIX A

DEFINITIONS AND ABBREVIATIONS

1. Certain words that appear frequently in this report are abbreviated as follows:

feet - ft

knot(s) - kt(s)

millibar or millibars - mb

nautical miles - mi

Weather Reconnaissance Squadron - WRS

2. Points of the compass are abbreviated: N, SE, WNW, etc.

3. Latitude and longitude are abbreviated: 30N 140E, etc.

4. An investigation is the traverse of a reconnaissance aircraft over an area containing a suspected circulation that has been assigned a cyclone number.

5. A fix is the determination of the position of a tropical cyclone at a precise time. Generally, the term "fix" is used when the position of the cyclone has been determined by a reconnaissance aircraft penetration or by airborne, land or ship radar. In the case of a reconnaissance aircraft penetration, the actual fix may be based on one or all of the following: visual observation, radar, surface pressure, surface or upper level winds, constant pressure height, and temperature/dew point.

6. A sortie is defined as a flight by one aircraft with one or more objectives, i.e., it may make one or more fixes and/or one or more investigations on one or more tropical cyclones.

7. The term "tropical cyclone" or "cyclone" as used in this publication has two definitions dependent upon usage.

a. "Tropical cyclone" or "cyclone" is used to describe a suspected tropical cyclonic circulation which appears capable of intensification, and to which has been assigned a "cyclone number" for the purposes of reconnaissance and to assure that records regarding it are not confused with those of another circulation.

b. "Tropical cyclone" or "cyclone" is used in the general sense, e.g., "Typhoon JOAN was the most intense tropical cyclone of 1959", or, "Tropical cyclones most frequently develop during August and September".

8. A tropical depression is a tropical cyclone with a confirmed cyclonic circulation, for which warnings are being issued and whose surface wind speeds do not exceed 33 kts. The numbering of tropical depressions is not related to the numbering of tropical cyclones.

9. Peel Island, located at 27.1N, 142.2E, is also known as Chichi Shima or Chichi Jima. In this report, only the name "Peel Island" is used.

10. The following define and clarify certain words and phrases that appear in the Tables, "Reconnaissance Aircraft Fixes", Chapter V.

a. FIX NO. - This number corresponds to the number of the fix plotted on the "Best Track Chart".

b. TIME - The date-time group of the fix.

c. LAT. - Latitude of the fix.

d. LONG. - Longitude of the fix.

e. UNIT METHOD & ACCY -

(1) UNIT - The unit that made the fix: 56 - 56th Weather Reconnaissance Squadron; 315 - 315th Air Division; VW1 - VW-1 Early Warning Squadron.

(2) METHOD - The method used to make the fix: P - penetration; R - radar; T - triangulation.

(3) ACCY - The estimated accuracy of the fix in nautical miles.

f. MIN SLP MBS - The minimum sea level pressure in millibars.

g. MAX SFC WND - The maximum observed surface wind in kts.

h. MIN 700MB HGT - The minimum 700 mb height in ft.

i. MAX 700MB WND - The maximum 700 mb wind in kts.

j. 700MB TT/Td (°C) - The maximum 700 mb temperature and dewpoint in degrees centigrade.

k. EYE CHARACTERISTICS - Selected remarks on the characteristics of the eye.

SC - strato-cumulus	INDEF - indefinite
CIRC - circular	ORIEN - oriented
CLD(S) - cloud(s)	QUAD(S) - quadrant(s)
CTR - center	RAD - radius
DIA - diameter	SFC - surface
ELLIP - elliptical	WND - wind
ELONG - elongated	

11. A "Stidd Diagram" is a chart on which a continuous plot of surface observations is maintained for a series of stations. The observations for each individual station are plotted in either a horizontal or vertical line.

12. The "M2 Field" (referred to in Chapter IV, Section B) is the correction for the coriolis parameter applied to the 500 mb double space mean.

13. The "Bar" (referred to in Chapter VII, Section C) is the heavy bank of clouds that appears on the horizon with the approach of an intense tropical cyclone.

APPENDIX B
LIST OF ILLUSTRATIONS

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LIST OF ILLUSTRATIONS (CONT'D)

APPENDIX B
LIST OF ILLUSTRATIONS (CONT'D)

Three Storms Prowl Pacific; P.I. Toll Hits 101

7 DEAD, 29 LOST IN JAPAN STORM

TOKYO (S&S)—Typhoon Della curved northward through the Sea of Japan Tuesday after cutting a swath across southern Japan, leaving 7 persons dead and 29 missing.

Two persons were killed and 21 were buried alive and are believed dead in a landslide at Nishinomiya, in Hyogo Prefecture. Police said hope has almost been abandoned for those trapped in the slide.

Dead, Missing Toll Nears 300 As Flood Waters Rise in P.I.

Typhoon Zig-Zags At Colony

Ship Looks Typhoon in the Eye and Escapes

By A/1C BERNARD W. KLOTS JR.

Lola Kills 26; Filipinos Face Food Shortage

Typhoon Smacks Southern Japan

'Lola' Leaves Battered P.I.

50,000 Formosans Rendered Homeless

By SPENCER MOOSA

TAIPEI, Aug. 2 (AP) — The Chinese Nationalist cabinet met in an emergency session today to work out measures to cope with the havoc caused in Formosa by Typhoon Shirley, which claimed possibly as many as 64 lives, rendered more than 50,000 persons homeless and disrupted rail and...

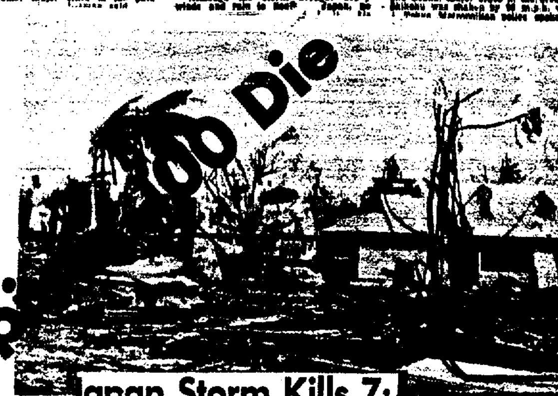
P.I. Storm Victims Get Food; Death Toll Rises to 29

27 Dead In Taiwan Typhoon

TOKYO—Casualty figures rose to 27 dead, 99 missing and 390 injured Wednesday morning from the floods which washed across Taiwan in the wake of typhoon Shirley.

69 Missing in Rough P.I. Waters; 4 Dead as Trix Batters Taiw…

Typh … akes Philipp … 00 Die



Japan Storm Kills 7; Toll May Reach 36

Typhoon Clobbers Luzon, PI

BULLETIN

By JIM BECKER

MANILA, June 27 (AP) — Typhoon Olive rolled up the … of the main Philippine island of Luzon today leaving seven dead and at least … missing in its wake.

'Olive' Kills 104 In PI; Off to China

Della Whips Nippon—19 Known Dead

TOKYO, Aug. 30 (AP)—The Japanese main islands, battered and bruised by Typhoon Della, braced today for more destructive onslaughts from a new tropical storm.

Della, which raked the main islands of Shikoku and Honshu over a 24-hour period, churned into the Japan Sea after having snuffed out the lives of 19, and possibly 20 persons, and sowing destruction to communications lines, shipping and homes.

5 Storms Swirl In Pa…

19 Missing

P.I. POUNDED BY TYPHOON

By SGT. ED GRANTHAM

MANILA — Typhoon Olive slammed into Manila early Monday morning with 75-m.p.h. winds and torrential rains.

A Philippine Navy spokesman said 19 persons had been lost at sea.

Winds Whip Waves Into Center of Manila

Typhoon Slams Iwo Jima

Carmen Rips Korea, Cancels War Game

Storm Off Hong Kong; 55,000 Homeless in P.I.

TYPHOON VICTIM MOVES PART OF HIS FAMILY TO SAFETY ON A RAFT
Storm Hit the Eastern Coast of Luzon in the Bicol Region Sunday Night

S&S Photos by Juanito Pardico

FILIPINOS ESCAPE FLOODS ON SECOND FLOORS AND ROOFS
97 Persons Were Dead, 29 Missing, and 55,000 Homeless

115-mph Winds Peril North Tip of Taiwan

Hundreds Lost in P.I. In Wake of Typhoon

MANILA (AP)—Nearly 100 persons were reported dead and several hundred missing on the main Philippine island of Luzon Monday night in the wake of Typhoon Olive, churning out into the South China Sea.

Manila, a city of 2 million, was partially paralyzed by the 80-m.p.h. winds and driving rain of the storm which hacked a northwest path across Luzon late Sunday and Monday.

Weathermen located Olive 142 miles northwest of Manila at 8 p.m. Manila time—still deadly—moving north northwest at 15 m.p.h.